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## **FOREWORD**

Presented number of Silesian University of Technology. Scientific Papers. Organization and Management Series. Contemporary management. Presented papers contain result of researches conducted by various universities from Poland. The number consists of 40 papers.

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about: public management, strategic management, quality management, environmental management, innovativeness, multicultural management, organizational culture, economics, logistics, safety management, knowledge management, risk management, information management, human resource management, impact of COVID-19 pandemic on management, technological change, leadership, business analytics, Smart City and Industry 4.0.

*Radosław Wolniak*



## THE MUNICIPAL PLAN FOR ADAPTATION TO CLIMATE CHANGE AND ITS ROLE IN THE STRATEGIC MANAGEMENT OF THE LOCAL AUTHORITY

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**Purpose:** The purpose of the article is to answer the question of how the challenges and problems of climate change translate into the realm of institutional solutions and strategic management at the local level.

**Design/methodology/approach:** The article uses the method of analysis and criticism of the literature, making an analytical-synthetic account of the state of knowledge to date on the topic presented. In terms of processing the collected data, inductive and deductive, descriptive and monographic reasoning methods were used.

**Findings:** Long-term strategies and investments in climate change adaptation as part of strategic management at the local level are essential to protect residents and urban infrastructure from the negative consequences of extreme weather.

**Practical implications:** The presented study can help local government units make effective decisions related to environmental management at the local level.

**Social implications:** The analysis presented can help in the process of identifying the benefits of strategic management with climate change adaptation issues.

**Originality/value:** The presented study represents a new approach to interpreting the assumptions of environmental management systems in the context of supporting climate change adaptation activities from the perspective of strategic management in organizations and local government units.

**Keywords:** climate change adaptation, spatial planning, city, strategic management, sustainability organization.

**Category of the paper:** Research paper.

## 1. Introduction

In the 1950s, 1/3 of the global population lived in cities. Just 50 years later, urban centres were home to half of humanity. According to UN data, in 2050, 2/3 of humanity, or an estimated 6 billion people, will lead their lives in urban agglomerations. The aforementioned upward trend implies a simple conclusion: the city attracts humans (Siekierska-Rosiak, 2016). There is nothing revelatory in this conclusion, emerging social, environmental, economic or cultural trends form in metropolises to then spill over to the rest of administrative units. In this respect, the city should play a pioneering role as an instrument of green transformation.

The process of transforming individual urban systems towards resilient, sustainable cities with a good quality of life is nowadays an essential element of urban spatial policy (Pancewicz, 2021). Space, on a par with forests, waters, mineral deposits, air, should be perceived as a resource and a supreme value, which the legal system must guarantee due protection. Hence, the recognition of the principle of sustainable development as the basis for spatial management is indisputable. The discussion on the concept of sustainable development is characterised by a multitude of definitions and interpretations of this concept, as indicated by various authors. Indeed, the term sustainable development is translated differently in Polish. Initially, it was translated as 'self-sustainable development' (sustain means to maintain, so it is primarily about maintaining the present state in order to be able to think about further development) or eco-development.

In Polish literature, eco-development is often equated with sustainable development. Today, however, there is some controversy about the meaning of the term. Most often, considering the legislation, it is considered that eco-development and sustainable development are synonyms. In such a situation, the terms are used interchangeably.

However, there are also other approaches. According to one of them, eco-development is a concept whose scope is narrower than sustainable development. According to S. Kozłowski (Kozłowski, 2005), head of the Polish delegation to the Earth Summit in Rio de Janeiro, eco-development means development based on natural criteria, whereas sustainable development is development understood integrally in the ecological, cultural and economic sense. Sustainable (self-sustaining) development is used most often in economic terms. According to Kozłowski, this is the broadest approach, very far from the concept of eco-development.

According to other authors, the situation is the opposite. In their opinion, the concept of eco-development includes, apart from the ecological dimension, other areas: cultural-institutional, demographic-social, technological-scientific, ethical-axiological, as well as economic. As a result, it can be concluded that eco-development is sustainable, sustainable and self-sustaining development.

It is significant that when the United Nations Environment Programme's Governing Council introduced the concept of eco-development in 1975, it implied "an imperative to deal pragmatically with the developmental interdependence of nature and society". Therefore, the concept of eco-development (Kukuła, 2003) was intended to encompass such measures for economic, social and civilisational development that take into account the scientific features of zoology and ecology and other natural sciences. It thus guarantees the protection and rational shaping of the living environment of contemporary mankind and the biosphere of our planet as mankind.

Summarising the above considerations, it can be said that the eco-development formula appears to be at least equivalent to the sustainable development formula.

As the scientific discussion develops and the idea of sustainable development becomes more widespread, there is a tendency to expand the three basic elements of the sustainability concept (i.e. the social, economic and ecological factor) to include new ones, such as institutional, institutional-political and moral or ethical.

Regardless of whether and how broadly the conceptual boundaries defining sustainable development are defined, it is very important to make it clear that sustainable development implies the need to maintain a balance in the natural and technical environment, as well as human spiritual balance. Significantly, one of the courses of action on both the local and regional side is the pursuit of sustainable development, and therefore the management of public issues requires that a set of commonly accepted values be adopted and respected, influencing the decisions that local authorities take (Domański, 2000). Local and regional authorities play an important role in the implementation of the sustainable development agenda, as they are responsible for the maintenance and care of technical infrastructure facilities, e.g. municipal management and water supply. The list of activities of local authorities that contribute to improving the attractiveness of an area can include a wide range of undertakings - e.g. concerning: promotion, marketing, financial support and land management. Similar activities should be carried out at the regional level - covering provinces (Szewczuk, 2010).

The issue of implementing the sustainable development programme seems to be the key issue for spatial planning in Poland. Sustainable spatial management should be understood as such planning activities that lead to a balanced spatial development, especially in relation to the projected population, based on respect for resources, especially natural resources. According to the assumption of P. Fogel (Fogel, 2010), spatial planning is the prioritisation and balancing of values based on conditions, including environmental conditions. On the basis of these, decisions are made about the use or development of land. In reality, it is difficult making choices and finding spatial trade-offs between the interests of the individual and the wider public interest. The visible results of local planning, widely reported in the literature, leave no doubt that planning decisions are very often made without taking into account relevant considerations.

In the context of the widespread principle of sustainable and balanced development, it is important to take ecological and social values into account in spatial management.

In the long term, spatial order shaped according to the principles of sustainable development can be a factor in economic development. It undoubtedly provides a stimulus to the economy. This is for several reasons. Firstly, the importance of a knowledge-based economy is now growing. Knowledge, unlike traditional factors of production, is an almost inexhaustible factor, and its growth depends, among other things, on the role of science in society and the amount of investment devoted to its development. The education and R&D sectors, which are largely public services and do not directly pursue economic objectives, in effect generate economic growth. Secondly, the development of a knowledge-based economy does not depend only on the growth of knowledge. It requires high quality human capital. Its quality is shaped not only by a well-developed educational infrastructure, but also by the infrastructure of the health care and cultural systems. As research shows, a favourable climate for innovation is provided by centres with a rich cultural life and a strong artistic environment. Thirdly, some branches of services that were considered to be non-productive, such as culture, are becoming important, innovative and highly profitable branches of the economy in developed countries. Fourthly, companies operating in the knowledge economy, looking for qualified employees, are locating themselves in places offering good living conditions, i.e. a clean environment and well-developed social infrastructure.

The phenomena indicated, although not exhausting the entire spectrum of the issue, clearly indicate that shaping spatial order in the spirit of sustainable development should ensure proper development of these functions. In the short term, they limit the effectiveness of the economic use of space, but in the long term they ensure stable economic growth and favourable living conditions, which is also linked to limiting and controlling the pressure exerted by human activity on the natural environment (Tarkowski, 2007). Shaping spatial order according to the principles of sustainable development also affects the level of investment attractiveness.

An important part of the process of designing adaptation measures can be the development of a municipal climate change adaptation plan. Adaptation actions can be part of good practices, i.e. actions that contain a certain potential for innovation and produce positive and concrete results (Bednarek, 2007). Good practices should be applicable by actors with similar characteristics under similar conditions and should be replicable. Like sets of rules, good practices must demonstrate their usefulness and value in achieving their intended objectives. In other words, the use of good practice aims to improve the standards of activities carried out in a specific area, such as climate change adaptation. The most important features of the concept of good practice are: efficiency, planning, effectiveness, innovation, ethicality and universality (Karwinska, 2008). An example of good practice in climate change adaptation could be projects that make use of the network of natural linkages that positively influence both living conditions in the city and the functioning of the natural environment in the city, including green areas such as parks, squares, greens and municipal water resources such as rivers, streams, ditches, lakes or reservoirs (so-called green-blue infrastructure).



An analysis of the available literature on the subject has shown the need for a wider interconnection between, on the one hand, the objectives and instruments of strategic management and, on the other hand, the objectives and actions that constitute responses to climate challenges. In particular, in the context of the role of municipal climate change adaptation plans in this process. Thus, the research presented here fills a gap in the literature and provides a new approach to strategic management that takes into account the climate issues dimension. The aim of the paper is to answer the question of how the challenges and problems of climate change translate into the realm of institutional solutions. This will help guide an assessment of the current debate on the relationship between strategic governance at the local level and climate challenges. In particular, it will help contribute to the development of broader patterns of solutions that can be applied in country practice. In the article, the first chapter describes the process of transformation of individual urban systems towards resilient cities, taking into account the principles of sustainable development. The second chapter presents methods. In turn, Chapter 3 discusses and presents opportunities for the implementation of local climate change adaptation plans by local development managers. Chapter 4, on the other hand, presents conclusions and launches the discussion - pointing out and identifying the benefits of integrating environmental and nature conservation issues into strategic management at the local level. At the same time, problem areas for Poland's environmental policy in the context of climate challenges were identified.

## **2. Methods**

The article uses the method of analysis and criticism of the literature, making an analytical-synthetic account of the state of knowledge to date on the topic presented. In terms of processing the collected data, inductive and deductive, descriptive and monographic reasoning methods were used. The aim of the applied method of analysing and critiquing the literature was to characterise the existing body of work and the directions of discussion, and to ensure that certain methodological rules were followed, related to ensuring the verifiability, reliability and cognitive value of the results. In addition, the paper uses a document analysis method.

The method consists of a quantitative and qualitative analysis of the content contained in these documents. Thanks to this method, concrete data on the effects of action related to the integration of environmental issues into the instruments of strategic management were obtained. The resulting data from secondary sources was used to assess strategic management needs that take climate change adaptation into account.

### **3. Research Results. Urban Climate Change Adaptation Plans – over-planned obligation or well thought-out tactic**

Urban spatial governance plays a key role in climate change adaptation. Particularly important for urban adaptation is the spatial planning process, which should take into account as interdisciplinary a development approach as possible, including environmental and social (Carter et al., 2015). More and more people are living in cities and climate change, such as extreme temperatures, floods, storms and sea level rise, is a growing challenge. In the 2014-2020 financial perspective, Municipal Climate Change Adaptation Plans were developed systemically for 44 cities as part of a project co-financed by the Operational Programme Infrastructure and Environment 2014-2020 (Programme, 2014-2020). Among these 44 cities were 39 cities with populations over 100,000. The development of these plans for cities with populations over 100,000 was a prerequisite to receive funding for climate change adaptation measures and projects. Due to the growing awareness of the risks posed by climate change, cities with fewer than 100,000 inhabitants have also decided to develop municipal adaptation plans. A climate change adaptation plan is a strategic document and provides the basis for decisions by the municipal authorities that would take into account the risks arising from climate change. The plan identifies adaptation actions leading to mitigation of the negative consequences of climate change. In addition, a Climate Change Adaptation Plan is a specialised document and usually requires the involvement of subject matter experts. When deciding to develop a climate change adaptation plan document on your own, it is worthwhile to describe the geographical and key socio-economic conditions (e.g. population of senior citizens, phenomena indicative of degradation of the JST, investment interest) before carrying out a diagnosis of hazards, vulnerability, adaptation potential, susceptibility and risk. It is also worth analysing the available strategic and operational documents, including those concerning the environment and climate protection, including those relevant to the regional and national level, e.g. the city/municipality development strategy, environmental protection programmes and/or the sustainable development programme, local spatial development plans, the study of the conditions and directions for spatial development of the commune, plans for the supply of heat, electricity and gas fuels, water and sewage management programmes, including the management of rainwater, programmes of small-scale retention, low-emission management programmes, natural valorisation and ecophysiological studies. The above-mentioned documents often do not directly refer to adaptation measures, but nevertheless identify the problems of a given administrative unit that may relate to risks resulting from the effects of climate change and define courses of action/ or specific actions. Public participation is important in the process of developing climate change adaptation plans, so a description of the involvement and participation of local residents in the development of the plan is necessary. When describing, on the basis of an assessment of the JST's exposure to selected climatic

phenomena, the main risks arising from climate change, it is worthwhile to make observations of changes in climatic conditions and to forecast them. At the stage of vulnerability analysis, it is advisable to analyse the functional and spatial structure, spatial management, public health, water management, transport, energy, biodiversity, cultural heritage, tourism and recreation. The assessment of adaptation potential, which is carried out next, aims primarily to identify elements of the functioning of the territorial unit that can help adapt to climate change or that, on the contrary, should be developed, improved and strengthened by adaptation measures in order to build the city's resilience to climate change. Adaptation potential should be considered in the following categories:

1. financial capacity,
2. social capital and access to knowledge,
3. crisis management,
4. health and social welfare institutions,
5. systemicity of protection and shaping of urban ecosystems.

The diagnosis concludes with a climate risk assessment. The completed diagnosis is the basis for setting the objectives of the adaptation plan, which will be implemented through specific adaptation actions. A success factor in the future implementation of the plan is the identification of the actors managing the city and assigning them an appropriate role. The implementation of the Adaptation Plan requires the participation of the inhabitants of the territorial selfgovernment unit as well as social organisations, in particular environmental groups at risk of exclusion. Entrepreneurs are also stakeholders in the MPA, especially those operating in the sector of specialisation of the territorial unit. An important element of the plan is the financial framework and sources of funding for adaptation measures and an ongoing monitoring schedule.

At almost every step in the development of the plan, there is a need to use up-to-date information and data, which can be a considerable challenge for small JSTs. Recommended documents are reports from governmental or scientific institutions. Reports prepared as part of bilateral and international projects on the topic by both the authority and other municipal entities can also be a good source of data. Global climate change scenarios have been developed by the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change, 2022). General information on projected climate change for Poland is presented in the document "Strategic adaptation plan for sectors and areas vulnerable to climate change until 2020 with an outlook until 2030" (Plan, 2013). Developed for the needs of the KLIMADA project at the Interdisciplinary Centre for Mathematical and Computational Modelling at the University of Warsaw, the climate change scenarios adapted for the conditions of Poland for the 2030 perspective are descriptions of likely future climate conditions. By drawing up an adaptation plan, the city can easily take a number of measures that will improve the comfort and functioning of its inhabitants. A climate change adaptation plan is also a new look for the municipalities, allowing them to revise their spatial documents, stop or green projects that

burden the environment, raise awareness of the risks of climate change, environmental education, their personal attitudes and commitment to adaptation.

In the area of climate change adaptation, the key is strategic management, which is a well-thought-out process with defined plans in an agreed timeframe, subject to constant monitoring and control. Such a concept is based on the development of endogenous potential and allows the formulation of long-term goals over a long time horizon. This allows the organisation's competitive advantage to be properly defined and positioned in its environment (Hausner, 2008). Developing adaptation plans and urban strategies requires a holistic approach to the issue and acting at different scales. It is also important to understand that blue infrastructure is a set of interconnected vessels and as such needs to be managed within a catchment area (Mazur, 2022).

Strategic management should be understood as a comprehensive and forward-looking approach to setting and achieving the development goals of a territorial self-government unit (Noworól, 2016). Such an approach makes it possible to maximise the rate of development of a given city and, consequently, the quality of life of its inhabitants. The definition of strategic management implies its primacy over the other elements of management, which include: operational management, preparation of medium-term and ongoing plans, and in the case of financial management: preparation of annual budget plans and long-term financial forecasts. The above-mentioned elements should be subordinate to the city's strategy and form a coherent system for its implementation.

Strategic management sets the priorities, objectives and agenda of a city (or more broadly of an organisation) in the long term. Management strategy is also defined, 'as a set of adapted ways of achieving its objectives according to the situation of that organisation and its environment' (Dobrowolski, 2017). According to the latest concepts, strategic management - is a prospectively planned, well-thought-out, effectively organised and efficiently implemented and continuously controlled process of formulating and implementing the organisation's development strategy. The main reason why local government units, and large cities in particular, need to apply a strategic approach is the increasingly competitive market in which cities compete for: external investors, financial resources or new residents. The results of this rivalry translate into tangible benefits for local communities (Ziolkowski, 2015). Strategic management manifests itself in the long-term definition of objectives and the use of tools that allow for the evaluation of the effects of action and the correction of the adopted methods of action. The main feature of modern systems is the efficient use of information and a strategic approach (Kozuch, 2008). Key strategic documents on urban development such as the National Urban Policy 2023 (Urban Policy, 2015) or the Strategy for Responsible Development (Strategy, 2017) are implemented in key strategic documents on the development of individual cities (Legutko-Kobus, 2017).

## 4. Conclusion and Discussion

Urban climate challenges are becoming more urgent in the face of climate change. Cities are particularly vulnerable to the impacts of these changes due to their population density, intensity of industrial activity and concentration of infrastructure. Addressing these challenges requires cooperation between local, regional and national governments and the involvement of local communities. It is necessary to take adaptation measures, invest in more sustainable infrastructure and promote climate awareness among residents to counter the effects of climate change in cities. Urban planning is a key tool in creating a more resilient and sustainable urban space that can deal more effectively with the challenges posed by climate change. Long-term strategies and investments in climate change adaptation as part of urban planning are essential to protect residents and urban infrastructure from the negative consequences of extreme weather. Urban climate change adaptation plans, on the other hand, are a tool in building urban resilience to the impacts of climate change. By integrating actions across sectors and collaboration between different actors, cities can better prepare for climate challenges.

In the literature cited in the article, one can find theses that the need to respond to climate challenges requires a kind of redefinition of strategic management instruments. In the literature, one can find a lot of assessments covering (both more universally and with regard to the case study of a specific country) guidelines related to spatial planning instruments. The next stage of the analysis is therefore to identify key trends in this subject area. Already at this stage, however, it has to be stated that the literature by far the most widely advocated framing of climate challenges within the framework of strategic management. Based on the analysis of the literature on the subject, it is possible to identify key lines of discussion regarding the relationship between climate challenges and strategic management objectives. The literature review carried out for the purposes of this article confirms opinions on the validity of the need to analyse the issues identified. In general, from different perspectives the role of strategic spatial planning is very often emphasised. This is associated with a broader expectation to broaden the analyses in spatial planning and to translate the results and conclusions of the indicated analyses more effectively into the regulatory sphere (which is a very difficult challenge).

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## ORGANIZATIONAL CITIZENSHIP BEHAVIORS AND PSYCHOSOCIAL WORKING CONDITIONS EXAMINED THROUGH THE PRISM OF FOR-PROFIT, PUBLIC AND NONPROFIT ORGANIZATIONS

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**Purpose:** The aim of the article is to determine the relationship between OCBs and psychosocial working conditions.

**Design/methodology/approach:** The survey was conducted using the OCB scale developed by Spector and the COPSOQ tool. Statistical analysis was carried out using Statistica software.

**Findings:** The research demonstrates that the manifestation of OCB-O by respondents correlated with more aspects of psychosocial working conditions than in the case of OCB-P. When analyzing OCB-O, strong correlations were reported with the following variables: possibilities for development, job satisfaction, and meaning of work. In the case of OCB-P, these correlations were moderate. In addition, in the case of OCB-O, a weak relationship was also identified with the following variables: quality of leadership, social support, and influence at work. These correlations were negligible for OCB-P. The obtained results demonstrate that quantitative demands do not correlate with either OCB-O or OCB-P. However, in what concerns influence at work variable, a weak correlation was identified for OCB-O as well as a negligible correlation for OCB-P.

**Research limitations:** The study was only quantitative and not qualitative, while the research relied solely on respondents' statements. The sample was selected purposively, which means the findings cannot be generalized, and the study involved only Polish organizations, meaning it was embedded in a specific cultural context. Additionally, the research was not a longitudinal study. The data was lagged, which does not allow for strong causal inference. The use of questionnaire-based research may have triggered a common method bias.

**Practical implications:** managers of any type of organization should do their best to encourage employees to display OCBs. This may be facilitated by appropriate psychosocial working conditions, especially in the areas of: possibilities for development, meaning of work, job satisfaction.

**Originality/value:** According to our findings, at the moment of writing this paper there are also no comparative studies examining the relationship existing between OCBs and working conditions covering the three types of organizations: for-profit, public, and nonprofit. Besides, in the course of reviewing the literature, we found no studies examining the relationship between OCBs and influence at work and quantitative demands.

**Keywords:** organizational citizenship behaviors; working conditions; for-profit, public and nonprofit organizations.

**Category of the paper:** Research paper.

## 1. Introduction

In the empirical research on Organizational Citizenship Behaviors (OCBs), two main trends can be distinguished. The first trend deals with the consequences of this type of behavior at the individual, unit and organizational level, whereas the second trend explores issues related to the antecedents of OCBs.

Primarily, OCBs have been studied in relation to job satisfaction (Bateman, Organ, 1983; Smith et al., 1983), organizational justice (Farh et al., 1990; Moorman, 1991; Niehoff, Moorman, 1993) and organizational commitment (Moorman et al., 1993; Williams, Anderson, 1991). Other analyses included dispositional factors: agreeableness, conscientiousness, positive and negative affectivity (Konovsky, Organ, 1996; Organ, Lingl, 1995). The relationship between OCBs on one hand and leader behaviors and task characteristics on the other hand has also been studied (Podsakoff et al., 1990; Podsakoff et al., 1996a, 1996b).

A separate category of antecedents explored in OCBs research have been those related to the job characteristics and the functioning of the organization, including: organizational formalization, organizational inflexibility, spatial distance (Podsakoff et al., 1996a, 1996b), workplace environment (Turnipseed, Murkison, 1996), perceived organizational support (Moorman et al., 1998). However, no studies were identified that would comprehensively analyze the relationship between OCBs and psychosocial working conditions as measured by the Copenhagen Psychosocial Questionnaire. Few researchers have used that instrument, and those who have, did so only to a limited extent (Jeon et al., 2018; Kosenkranius et al., 2020; Wemken et al., 2021).

Let us also point out that, in what concerns OCBs, some of the variables contained in the COPSOQ were also analyzed, including: meaning of work (Maharaj, Schlechter, 2007; Chandra et al., 2017), social support (Kim et al., 2013; Halbesleben, Wheeler, 2015) or health (e.g. Baranik, Eby, 2016; Fu et al., 2022; Htun, 2022; Jain, 2009). However, no studies seem to have analyzed OCBs in detail in relation to variables such as, for example, quantitative demands or influence at work. According to our findings, at the moment of writing this paper there are also no comparative studies examining the relationship existing between OCBs and working conditions covering the three types of organizations: for-profit, public, and nonprofit.

The aim of the article is to determine the relationship between OCBs and psychosocial working conditions. To this end, a survey was conducted.

The article is divided into sections, which are as follows: introduction, literature review, methods, results, discussion, and conclusion. In the introduction, the directions of research on organizational citizenship behaviors, the research gap and the purpose of the article are synthetically laid out. In the second section, the results of the literature review on OCBs are presented, while the third section addresses the relationship existing between OCBs and selected aspects of psychosocial working conditions. Section four contains a description of our research methodology, and section five is where the results are shared. In the last section, the results are benchmarked with some of the findings of other authors, indicating implications for managers as well as limitations and directions of future research.

## **2. Organizational Citizenship Behaviors**

According to the classic definition presented by Organ (1988), OCB is an individual behavior that is discretionary, not explicitly recognized by the formal reward system, and that in the aggregate promotes the effective functioning of the organization. Under this view, OCBs include behaviors that go beyond role-related requirements and are organizationally functional. Some researchers have pointed out that organizational citizenship behaviors are a function of how employees perceive their duties at work (Morrison, 1994) and that type of behavior is accounted for by managers in areas such as recruitment (Podsakoff et al., 2011) and employee evaluation (MacKenzie et al., 1993). Later and Organ (1997; compare: Van Dyne et al., 1994) modified his original definition, stating that OCBs support the social and psychological environment in which task performance takes place. As noted by LePine et al. (2002), the definition of OCB thus became similar to the definition of Contextual Performance presented by Borman and Motowidlo (1997).

An important part of the conceptualization was the recognition of the dimensions of OCBs. Smith et al. (1983) identified to that end altruism and generalized compliance, whereas Organ (1988) distinguished: altruism, conscientiousness, sportsmanship, courtesy, and civic virtue. The taxonomies of organizational citizenship behaviors were also developed among others by Graham (1991), Podsakoff et al. (2000), Borman et al. (2001), Van Dyne et al. (1995). Williams and Anderson (1991) for their part argued that OCBs can be reduced to behaviors that ‘benefit the organization in general’ (OCBO) and ‘immediately benefit specific individuals and indirectly through this means contribute to the organization’ (OCBI).

As already mentioned, the essence of the definiens of OCBs are the functionality of organizational citizenship behaviors that drives the direction of research on the consequences of this type of behavior at the individual, work-group, unit and organizational level. The relationship between OCBs and performance, including profitability, productivity, product quality and efficiency have been tested (Podsakoff et al., 2013; Podsakoff, MacKenzie, 1997;

Podsakoff et al., 1997). However, the leading direction has been the diagnosis of the antecedents of organizational citizenship behaviors. Primarily, OCBs have been studied through the prism of attitudinal and perceptual variables. The relationship between OCBs and job satisfaction (Bateman, Organ, 1983; Smith et al., 1983), organizational justice (Farh et al., 1990; Moorman, 1991; Niehoff, Moorman 1993) and organizational commitment (Williams, Anderson 1991; Moorman et al., 1993) have been studied. The research was further elaborated by the question of which of the attitude components is the determinant of OCBs (Organ, Konovsky, 1989; Williams, Anderson, 1991; Lee, Allen, 2002). Other analyses have focused on individual differences: agreeableness, conscientiousness, positive and negative affectivity (Organ, Lingl, 1995; Organ, Ryan, 1995; Konovsky, Organ, 1996; Borman et al., 2001), equity sensitivity (Konovsky, Organ, 1996; Blakely, Andrews, Moorman 2005), locus of control (Borman et al., 2001; Blakely, Srivastava, Moorman, 2005), motives, motive fulfilment and role identity (Rioux, Penner, 2001; Finkelstein, Penner, 2004; Finkelstein, 2006). The relationship between OCBs and leader behaviors has also been explored (Podsakoff et al., 1990; Podsakoff et al., 1996a and 1996b; Babcock-Roberson, Strickland 2010; Harris et al., 2014). Factors related to job characteristics and the functioning of the organization constituted a separate category, including: organizational formalization, organizational inflexibility, spatial distance (Podsakoff et al., 1996a, 1996b), and perceived organizational support (Alshaabani et al., 2021; Moorman et al., 1998).

### **3. OCBs and psychosocial working conditions**

An analysis of the content of the Google Scholar database revealed that the COPSOQ was used in the course of research on OCBs (albeit to a limited extent) e.g. by Jeon et al. (2018) who conducted a quasi-experimental study evaluating the effects of six-month intervention (ethical leadership program for nursing unit managers). To that end, they used six dimensions of the medium-sized Copenhagen Psychosocial Questionnaire II. Furthermore, Kosenkranius et al. (2020) set it out to verify whether off-job crafting intervention could offer performance benefits for the employers such as increased organizational citizenship behaviors among employees. The COPSOQ was used by them to measure cognitive job demands and emotional job demands. Wemken et al. (2021) also mention using six items of the COPSOQ to measure job demands in their study, although the obtained results were not presented as they went beyond the scope of their research.

Some of the variables included in the Copenhagen Psychosocial Questionnaire were also analyzed through the prism of OCBs. Research has frequently been carried out using scales other than those contained in the COPSOQ.

Classic studies have demonstrated a positive relationship between OCBs and job satisfaction (Bateman, Organ, 1983; Smith et al., 1983; Williams, Anderson, 1991). Meta-analyses have also confirmed this correlation (Organ, Ryan, 1995; LePine et al., 2002). Subsequent research – following the suggestion of Organ and Konovsky (1989) – focused on the fairness interpretation of OCBs. Meanwhile, research results obtained by Farh et al. (1990), Moorman (1991), Moorman et al. (1993) suggested that perception of justice is a better predictor of OCBs than job satisfaction.

The relationship between OCBs and perceived organizational support (POS) has also been studied in the context of social exchange theory. A positive correlation was found between POS and OCBs (Wayne et al., 1997; Chiang, Hsieh, 2012). According to Moorman et al. (1998), procedural justice is an antecedent to POS which in turn mediates its relationship to three OCBs dimensions (interpersonal helping, personal industry and loyal boosterism). It was also found that POS mediated the effects of interpersonal and informational justice on organizational citizenship behavior that are directed at the organization (OCBO) and its members (OCBI) (Cheung, 2013). According to Shanock and Eisenberger (2006) supervisors' POS is positively related to their subordinates' perceived supervisor support (PSS) and, in turn, subordinates' PSS is positively associated with their POS, in-role performance, and extra-role performance. Halbesleben and Wheeler (2015) - driven by the assumptions of the conservation of resources theory - found that higher perceived co-worker support is positively associated with greater investment in OCBs aimed at that co-worker. Whereas Kim et al. (2013), referring to the concept of motives in OCBs research, demonstrated, among others, that the quality of social support functions as a boundary condition that qualifies relations of motives with OCBs.

In the study, emphasis was also placed on meaningfulness as an antecedent of OCBs. It was demonstrated that the meaningfulness of work was significantly correlated with OCBs and also significantly predicted variance in OCBs (Sharma, 2019) and employees' perception of the meaningfulness of work had a significant positive influence on OCBs (Youn, Kim, 2022). In this context, research on employees not receiving any remuneration was also carried out. Erks et al. (2021) found that meaningfulness of volunteers is related to both employee engagement and OCBs at work. Meanwhile, Im and Chung (2018) found that organizational pride and trust mediates the relationship between employee volunteering meaningfulness and OCBs.

Numerous studies have been conducted on the relationship between leadership and OCBs (e.g. Farh et al., 1990; Jiao et al., 2011; Yang, Zhang, 2022). For instance, Podsakoff et al. (1990; compare Podsakoff et al., 1996a) indicated that the effects of the transformational leader behaviors on OCBs are indirect, rather than direct, they are moderated by followers' trust in their leaders. The research results indicated also a significant positive relation between charismatic leadership and OCBs (Babcock-Roberson, Strickland, 2010). The relationship between LMX (leader-member exchange) and OCBs was analysed, too (Harris et al., 2014).

The relationship between employee competency and OCBs has also been studied (e.g. Chuang et al., 2019; Hardin et al., 2020; Sumarsi, Rizal, 2022; Wortler et al., 2019), and so has been the relationship between (high-performance) HR practices and OCBs (e.g. Wei et al., 2010; Sun et al., 2007; Gupta, Singh, 2010; Snape, Redman, 2010). Conducting research in this area, Wei et al. (2010) included internal career opportunities and extensive training among HR practices. Against their expectations, their research has revealed that high-performance HR practices are not significantly related to OCBs. Different conclusions were provided by the study of Nadeem et al. (2019). By analyzing the relationship between HR practices (including competency development) and OCB, they determined that a high-performance work system is positively correlated with organizational citizenship behavior (compare: Snape, Redman, 2010). In addition, according to Sun et al. (2007; as quoted in Wei et al., 2010), ‘high-performance HR practices can shape positive psychological climate perceptions of employees since such HR practices would send a signal of long-term investment in employee competence, helping create shared employee perceptions of a supportive organizational context that encourages OCB’. Therefore, the results of the research conducted so far in this area are inconclusive.

Some studies have also been identified which have verified the impact of health on organizational citizenship behaviors. Researchers working in this field have concluded, among other things, that OCBs are positively related to employees’ health complaints (Fu et al., 2022) or health and safety has significantly positive effect on OCBs of employees (Htun, 2022). Baranik and Eby (2016) identified that a positive effect mediated the relationship between OCB-Is and general health. This issue has also been analyzed by Jain (2009). According to him, the dimensions of OCBs, namely organizational pride, social and functional participation and concern for organizational resources were found to be the positive predictors of the dimension of general health called sense of accomplishment and contribution. Moreover, the dimensions of OCBs, namely sportsman spirit and concern for organizational resources were found to be the positive predictors of the dimension of general health called hassle-free existence. Another study indicated that there was a significant positive effect of altruism, civic virtue and sportsmanship (dimensions of OCBs) on subjective well-being while conscientiousness (dimension of OCBs) had a negative impact on subjective well-being of employees (Yurcu et al., 2015). In the contrast, research by Naz et al. (2021) has revealed, that there is no significant interaction between general health and OCB

No studies have been identified that would examine in detail the relationship between OCB and quantitative demands or an influence at work.

## 4. Methods

The research process consisted of the following stages: literature analysis, research gap identification, formulation of research questions and hypotheses, sample and research tools selection, data collection and analysis, conclusions formulation, indication of research limitations and future directions. The research hypotheses were formulated as follows: H<sub>1</sub>: OCB-O is positively associated with psychosocial working conditions in the organization (quantitative demands, influence at work, meaning of work, possibilities for development, social support, quality of leadership, job satisfaction, general health). H<sub>2</sub>: OCB-P is positively associated with psychosocial working conditions in the organization (quantitative demands, influence at work, meaning of work, possibilities for development, social support, quality of leadership, job satisfaction, general health).

### 4.1. Sample

The study was conducted in 2022, in Poland's Lubuskie Voivodeship. The sample consisted of employees representing three types of organizations: for-profit, public and nonprofit. The sampling was non-random. No list of employees working in organizations of Lubuskie Voivodeship was available. The survey included three hundred respondents, a hundred from each type of entity. The participation in the study was voluntary.

There were more women (60.67%) than men among the respondents. The average age of participants in the research was 37.9. Most respondents (34.67%) had less than three years of work experience in the current organization, while slightly fewer had more than ten years (33.33%) or between four and ten years (32.00%) of work experience.

Most representatives of for-profit and public organizations held executive positions (79.50%). More than a third (37.50%) were employed in large entities, more than a quarter (25.50%) – in medium-sized entities. The fewest respondents worked in small (22.50%) or micro (14.50%) organizations. Most representatives of nonprofit entities were board members (43.00%). Every fourth (26.00%) was a paid employee. Members of organizations (19.00%) and volunteers (12.00%) were represented less. They were active in associations (79.00%), foundations (18.00%) or other entities (3.00%). More than every third nonprofit representative (38.00%) worked in an entity employing 10 or fewer people, and slightly fewer respondents - in an organization employing 11 to 20 people (31.00%) or more than 50 (22.00%). The fewest respondents from this group worked in entities employing from 20 to 49 people (9.00%).

## 4.2. Measures

Various research tools can be used to measure OCBs (e.g. Fox et al., 2012; Konovsky, Organ, 1996; Lee, Allen, 2002; Podsakoff et al., 1990; Spector et al., 2010; Williams, Anderson, 1991). In the course of our own research, we used - similarly to Glińska-Neweś and Szostek (2018) - the 12-item OCB scale developed by Spector (Organizational Citizenship Behavior Checklist...). Respondents were asked to choose one of the answers on a five-point scale (never - 1, once or twice - 2, once or twice a month - 3, once or twice a week - 4, every day - 5). The score was then calculated simply as the average of responses from 1 to 5. Six items in the survey concerned behaviors directed towards the organization (OCB-O), while another six concerned behaviors towards people in the organization (OCB-P).

Various research tools can also be used to measure psychosocial conditions at work (for more, see: Baka, 2019). An international, standardized instrument used by the World Health Organization and the International Labor Organization for assessing psychosocial working conditions, health and well-being of employees is the Copenhagen Psychosocial Questionnaire (COPSOQ) (compare Baka et al., 2019)<sup>1</sup>. It was first developed in 2000 by Kristensen and Borg and is now available in 25 languages (<https://www.copsoq-network.org/>, 7.05.2022). It accounts for a broad spectrum of psychosocial working conditions and can be used in a number of economic sectors such as industry, services, communication (Baka, 2019). The COPSOQ has been validated in many countries (e.g. Berthelsen et al., 2014; Dupret et al., 2012; Moncada et al., 2014; Rosário et al., 2017; Nübling et al., 2006), including in Poland. The research work of Widerszal-Bazyl (2017) demonstrated that the eight scales of the COPSOQ II in the Polish version can be used in research examining psychosocial properties of work, considering them to be reliable and accurate. The results of analyses conducted by Baka (2019) also confirmed the high accuracy and reliability of the Polish version of the COPSOQ II. It was precisely this tool that we used in the course of our own research, namely the COPSOQ version validated in Polish conditions by Widerszal-Bazyl (2017), who confirmed the reliability of the following eight scales: 'Quantitative demands', 'Influence at work', 'Meaning of work', 'Social support', 'Job satisfaction', 'Possibilities for development' (4-question version; the 2-question version was unreliable), 'Quality of leadership', 'General health'. As in the original tool, the majority of the questions in the questionnaire were answered by participants using a five-point scale (varying from 'to a very little extent' to 'to a very large extent' or 'never/almost never' to 'always/almost always'). The exception was the 'Job Satisfaction' scale where the responses were: very satisfied, satisfied, dissatisfied, very dissatisfied, irrelevant/not applicable. The scales of the COPSOQ are formed by adding the points of the individual questions of the scales by giving equal weights to each question. These weights are as follows: 100, 75, 50, 25, 0. The scale value is calculated as the simple average - all scales go from 0 to 100. According to the instruction, respondent who answered less than half of the questions in a scale is regarded as missing (<http://www.mentalhealthpromotion.net/>..., 20.05.2022).



The survey research came with certain limitations such as the need to rely on respondents' statements, limiting the territorial scope to one country, non-random sampling, or common method bias.

### 4.3. Data analysis

The statistical analysis of the data was carried out using the Statistica software. The internal consistency was confirmed using the standard Cronbach's alpha coefficient (Cronbach, 1951). It adopted the following values: 0.804436776 (OCB), while 0.854676525 (COPSOQ)<sup>2</sup>. Subsequent analyses showed that the OCB-O and OCB-P variables have a distribution close to normal, while the remaining eight variables ('Quantitative demands', 'Influence at work', 'Social support'<sup>3</sup>, 'Job satisfaction', 'Possibilities for development', 'Meaning of work', 'Quality of leadership', 'General health') did not. This was confirmed by the results of the Shapiro-Wilk tests (Shapiro, Wilk, 1965)<sup>4</sup> (Table 1).

**Table 1.**

*Shapiro-Wilk test results for variables included in the OCB and COPSOQ tools*

Variables	<b>p</b> <b>For-profit</b> <b>(N = 100)</b>	<b>p</b> <b>Public</b> <b>(N = 100)</b>	<b>p</b> <b>Nonprofit</b> <b>(N = 100)</b>	<b>p</b> <b>Total</b> <b>(N = 300)</b>
<b>OCB-O</b>	.00697	.21005	.23868	.081318
<b>OCB-P</b>	.03042	.61166	.08249	.100427
<b>Quantitative demands</b>	.03767	.03577	.03684	.000195
<b>Social support</b>	.00177	.07623	.00095	.000007
<b>Influence at work</b>	.00485	.00663	.00012	.000001
<b>Job satisfaction</b>	.00000	.00001	.00000	.000000
<b>Possibilities for development</b>	.02448	.00179	.00532	.000012
<b>Meaning of work</b>	.00155	.00041	.00000	.000000
<b>Quality of leadership</b>	.02553	.01787	.00219	.000000
<b>General health</b>	.00370	.00339	.02600	.000024

Explanation: - rejection the hypothesis of normality.

Source: own study.

As a result, the majority of subsequent analyses of variables were conducted using non-parametric statistics. In the case of correlation analysis, a rule was adopted (similarly to e.g. Paliga, 2021) that when the distribution of at least one of the variables in a pair deviates from the normal distribution, the analysis of the relationship is carried out using Spearman's rho coefficient.

## 5. Results

Respondents stated that most of the analyzed behaviors were manifested once or twice at all or once or twice a month. The respondents' average ratings for individual OCBs dimensions were as follows: 2.97 (OCB-O) and 2.88 (OCB-P) (let us recall the scale was from 1 to 5).

Participants in the study also assessed psychosocial working conditions in their organizations. Average ratings are shown in Table 2 (let us recall that items included in individual subscales could be assigned 100, 75, 50, 25 or 0 points). The highest average ratings were recorded for the following subscales: 'Job satisfaction' (71.13), 'Meaning of work' (71.06), 'Possibilities for development' (69.13), while the lowest for the subscales 'General health' (50.07) and 'Quality of leadership' (50.07).

**Table 2.**

*Evaluation of psychosocial working conditions - the perspective of research participants<sup>5</sup>*

Psychosocial working conditions (COPSOQ subscales)	Arithmetic means (N = 300)
Job satisfaction	71.13
Meaning of work	71.06
Possibilities for development	69.13
Influence at work	64.50
Social support	62.54
Quantitative demands	57.31
Quality of leadership	55.68
General health	50.07

Source: own study.

In order to verify the research hypothesis describing the relationship between OCBs (OCB-O and OCB-P) and psychosocial working conditions, a correlation analysis was performed using Spearman's rho coefficient. This decision, as already mentioned, was motivated by the failure of both analyzed variables to meet the assumptions regarding the normality of distribution. The results of calculations concerning Spearman's rho coefficient were interpreted as per the Dancey and Reidy (2004) classification<sup>6</sup>.

Spearman's rho values were analyzed separately for the two OCB subscales. The results obtained for the OCB-O subscale are shown in Table 3.

**Table 3.**

*Spearman's rho coefficient values for the variables: OCB-O and psychosocial working conditions*

OCB-O and:	Spearman's rho			
	For-profit (N = 100)	Public (N = 100)	Nonprofit (N = 100)	Total (N = 300) <sup>7</sup>
Job satisfaction	.490305	.531123	.336725	.442378
Possibilities for development	.555628	.398137	.339517	.427580
Meaning of work	.548126	.530713	.263388	.426115
Quality of leadership	.165712	.360045	.289515	.271359
Social support	.239968	.277164	.277151	.254233
Influence at work	.270486	.256628	.253451	.253207
General health	-.041846	.244816	.097550	.102585
Quantitative demands	.089868	-.018034	.026176	.029617

\* p < 0,05

Source: own study.

By analyzing the correlations of OCB-O and individual variables contained in the COPSOQ (for N = 300), it was found that the majority of them were positive. Only two of them can be described as negligible (namely 'Quantitative demands' and 'General health').

A weak correlation was reported for the subscales: ‘Influence at work’, ‘Quality of leadership’ and ‘Social support’, while a strong correlation was reported for the subscales: ‘Possibilities for development’, ‘Meaning of work’ and ‘Job satisfaction’. Thus, the basis for confirming the H<sub>1</sub> hypothesis was found, but the identified correlations had different strengths.

In the analyzed for-profits, the highest correlations were recorded for the variables OCB-O and ‘Possibilities for development’, ‘Meaning of work’, ‘Influence at work’. In public organizations, the highest correlations, compared with the rest, were observed for ‘Job satisfaction’ and ‘Quality of leadership’, whereas in nonprofit entities - for the ‘Social support’ subscale.

Table 4 shows the results of the correlation analysis for OCB-P and particular COPSOQ subscales.

**Table 4.**

*Spearman's rho coefficient values for the variables: OCB-P and psychosocial working conditions*

OCB-P and:	Spearman's rho			
	For-profit (N = 100)	Public (N = 100)	Nonprofit (N = 100)	Total (N = 300) <sup>8</sup>
Possibilities for development	.433465	.246208	.269932	.333343
Meaning of work	.428772	.415058	.100368	.319922
Job satisfaction	.314849	.445969	.222976	.319157
Quality of leadership	.162760	.286553	.151173	.185611
Influence at work	.126373	.186450	.213842	.181191
Social support	.139299	.252327	.169674	.176174
General health	.074106	.327473	.021323	.140749
Quantitative demands	.015292	.057132	-.052256	.012936

\*  $p < 0,05$ .

Source: own study.

The correlations between OCB-P and COPSOQ subscales were not as marked. Analyzing them among 300 respondents, they were indeed positive but only three were slightly above the 0.3 threshold denoting moderate correlation (those were: ‘Possibilities for development’, ‘Meaning of work’, ‘Job satisfaction’). Thus, the basis for confirming the H<sub>2</sub> hypothesis was found, but the identified correlations had different strengths. Only three cases showed a moderate correlation.

In the analyzed enterprises, the highest correlations (moderate) were observed for the following subscales: ‘Possibilities for development’ and ‘Meaning of work’ (where ‘Meaning of work’ had a similar value also in public organizations). Meanwhile, ‘Job satisfaction’, ‘Quality of leadership’, ‘Social support’, ‘General health’ and ‘Quantitative demands’ were identified as the most important in public organizations. In nonprofits, the analyzed correlations had the highest value only in the case of ‘Influence at work’.

## 6. Discussion & Conclusions

The research demonstrates that the manifestation of OCB-O by respondents correlated with more aspects of psychosocial working conditions than in the case of OCB-P. When analyzing OCB-O, strong correlations were reported with the following variables: ‘Possibilities for development’, ‘Job satisfaction’, and ‘Meaning of work’. In the case of OCB-P, these correlations were moderate. In addition, in the case of OCB-O, a weak relationship was also identified with the following variables: ‘Quality of leadership’, ‘Social support’, and ‘Influence at work’. These correlations were negligible for OCB-P. On the whole, the conclusion can be drawn that favourable psychosocial working conditions are associated to a greater extent with OCB-O than with OCB-P. This finds its theoretical justification in social exchange theory (compare Moorman et al., 1998; Organ, Konovsky, 1989; Wayne et al., 1997).

The results of the conducted research have therefore demonstrated that the strongest correlations with OCBs (both OCB-O and OCB-P) include aspects of psychosocial working conditions (measured using the COPSQ) such as: ‘Job satisfaction’, ‘Possibilities for development’ and ‘Meaning of work’. This confirms what emerges from the classic studies on the relationship between job satisfaction and OCBs, namely that there is a positive correlation between these variables (Bateman, Organ, 1983; Smith et al., 1983; Organ, Ryan, 1995; LePine et al., 2002). Previous research has also demonstrated that OCBs positively correlate with ‘Meaning of work’ (Sharma, 2019; Youn, Kim, 2022; Erks et al., 2021). However, previous findings on the relationship existing between OCB and competency development were not always unambiguous (compare Nadeem et al., 2019; Snape, Redman, 2010; Wei et al., 2010).

In the course of reviewing the literature, we found no studies examining the relationship between OCBs and influence at work and quantitative demands. Our study has filled this research gap. The obtained results demonstrate that the quantitative demands do not correlate with either OCB-O or OCB-P. However, in what concerns the influence at work variable, a weak correlation was identified for OCB-O as well as a negligible correlation for OCB-P.

The results of the conducted research have also highlighted the differences in the relationship between OCBs and individual aspects of psychosocial working conditions, depending on the type of organization (for-profit, public and non-profit). Firstly, in the case of nonprofit entities, the relationship between OCBs and particular aspects of working conditions was not as strong. The biggest difference concerned the meaning of work aspect. In the case of nonprofits, the relationship between job meaning and OCB-P was negligible, and weak with OCB-O. In the remaining organizations, these correlations were consistently strong. Nonprofit entities are mission-driven in nature, and their activity is related to the fulfilment of important social needs (compare Moore, 2000; Rothschild, Milofsky, 2006); as such, working for them is frequently associated with a high level of meaning of work. However, as our research finds, it does not correlate strongly with OCBs. These findings are inconsistent with

the findings of Erks et al. (2021). Let us note, however, that in that study the primary focus was on volunteers, whereas our research also involved paid employees employed in the NPO sector. Additionally, job satisfaction in non-profit organizations as compared to for-profit and public organizations was also less strongly correlated with either OCB-O or OCB-P. Secondly, in public organizations, a larger number of psychosocial aspects of working conditions correlated more strongly with OCB-O and OCB-P than with the other two types of entities. This concerned, for example, the relationship between OCB-P and: 'Quality of leadership', 'Social support', 'General health'. Furthermore, in public organizations, OCB-O and OCB-P correlated more strongly with general health than in the remaining entities. Thirdly, in for-profit organizations, the difference consisted in the fact that there was a weaker correlation between OCB-O and 'Quality of leadership'. Meanwhile, in the case of OCB-P, there was a strong correlation with 'Possibilities for development', contrary to the remaining entities where it was weak.

The implications and practical research recommendations arising from this study are such that managers of any type of organization should do their best to encourage employees to display OCBs (both OCB-O and OCB-P). This may be facilitated by appropriate psychosocial working conditions, especially in the areas of: possibilities for development, meaning of work, and job satisfaction.

Finally, let us point out some of the limitations of this research. The study was only quantitative and not qualitative, while the research relied solely on respondents' statements. The sample was selected purposively, which means the findings cannot be generalized, and the study involved only Polish organizations, meaning it was embedded in a specific cultural context that should be accounted for when formulating conclusions. Additionally, the research was not a longitudinal study, but a cross-sectional one. The results may be different in a longitudinal study. The data was lagged, which does not allow for strong causal inference. Moreover, the use of questionnaire-based research may have triggered a common method bias.

A better understanding of this problem area would require more in-depth qualitative research studies and the use of techniques based on direct contact, interviews, observation, case study, etc. which would help capture its nuance more thoroughly. Future research using longitudinal data is also recommended. Further research might also consider verification of our research results on the relationship existing between OCBs and 'Quantitative demands' and 'Influence at work'. At the same time, it is worth continuing research on the differences between for-profit, public and nonprofit organizations in the area of OCBs.

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### Footnotes

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- <sup>1</sup> Currently, the COPSOQ III is available in short, middle and long versions (Burr et al., 2018; Llorens et al., 2019).
  - <sup>2</sup> The scales forming part of the tool should exhibit a value of the  $\alpha$ -Cronbach's coefficient larger than 0.7. Questionnaires whose  $\alpha$ -Cronbach's coefficient is smaller than 0.6 should not be used (Brzeziński, 2011).
  - <sup>3</sup> Except for the 'Social support' subscale in public organizations. As the variables OCB-O, OCB-P and social support had distributions close to normal, the use of Pearson's r correlation coefficient was considered to analyse the relationships between them. However, the analyses undertaken excluded this possibility, as the relationships between these variables did not appear to be linear. Since the conditions for calculating Pearson's r correlation coefficient were not met, again, it became necessary to use its non-parametric counterpart, the Spearman rank correlation coefficient.
  - <sup>4</sup> If the p-value is less than the conventional level of 0.05, then we reject the hypothesis of normality (Dudley, 2012).
  - <sup>5</sup> Calculations were made for N = 300, except for the 'Quality of leadership' scale (where N = 296). The difference is due to the fact that four respondents (in leadership positions) did not have a direct supervisor.
  - <sup>6</sup> Interpretation of Spearman's rho:  $\geq 0.70$  (very strong correlation), 0.40-0.69 (strong correlation), 0.30-0.39 (moderate correlation), 0.20-0.29 (weak correlation), 0.01-0.19 (no or negligible correlation) (Dancey, Reidy, 2004).
  - <sup>7</sup> Let us recall, that calculations were made for N=300, with the exception of the 'Quality of leadership' scale (N = 296).
  - <sup>8</sup> Let us recall once again, that calculations were made for N=300, with the exception of the 'Quality of leadership' scale (N = 296).





## UNETHICAL PRO-ORGANISATIONAL BEHAVIOUR AIMED AT UNDERMINING QUALITY

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**Purpose:** The primary purpose of this article is to identify the manifestations and causes of unethical pro-organisational behaviour related to the lowering of quality, as well as to propose measures that could prevent such behaviour.

**Design/methodology/approach:** The main research method used was a literature review. The applied procedure was in line with the general methodology for conducting research in management sciences (Easterby-Smith et al., 2015). Exemplification was used as an ancillary research tool.

**Findings:** Manifestations of unethical pro-organisational behaviour aimed at the lowering of quality include falsifying system documentation, hiding quality errors that occur in individual processes, deliberately impairing product quality by reducing the quantity of particular components or replacing them with lower-quality substitutes, providing customers with a completely different product under the organisation's own name and reducing quality objectives. Paradoxically, the occurrence of such behaviour is fostered by excessive identification, affective commitment, organisational support resulting in a sense of indebtedness to the organisation, pressure for results and even satisfaction with one's job. The possible measures that could prevent unethical pro-organisational behaviour include the following: applying the principle of positive discipline, entering into transparent psychological contracts, abandoning annual employee appraisals, employee rankings and bonus systems whose results depend on employee cooperation, as well as the variable part of managers' remuneration.

**Research limitations/implications:** A literature review is not a perfect way to obtain information. The article does not discuss all causes and manifestations of unethical pro-organisational behaviour that may occur in organisations oriented towards quality.

**Practical implications:** Based on the conclusions formulated on the basis of the conducted research, managers can significantly reduce the development of unethical behaviour (mainly by following the recommendations of E. Deming).

**Originality/value:** While there is a large body of literature on the causes of unethical pro-organisational behaviour, very little is known about their causes and manifestations in organisations focused on quality.

**Keywords:** pro-organisational behaviour, ethics, quality management, organisational sociology.

**Category of the paper:** conceptual paper.

## 1. Introduction

In 2011, E.E. Umphress and J.B. Bingham, in the journal *Organization Science*, found that employees sometimes engaged in unethical actions with the intention of benefiting their organisation, and named such actions as unethical pro-organisational behaviour (UPB) (Umphress, Bingham, 2011). It seems that in the initial period unethical pro-organisational behaviour is a positive phenomenon, as it protects the company's image, safeguards its interests and increases profits. However, in the long run and when detected, such behaviour causes many negative consequences and has a potentially destructive impact on stakeholders, other organisations and even society as a whole (Yang, Wei, Wu, 2021), creates stress and leads to conflicts of interest between work and family, undermines employee morale and reputation (Liu et al., 2021; Chen, Kwan, Xin, 2022), is the cause of declining trust and credibility (Vem et al., 2023).

Such behaviour has various manifestations (e.g. deleting harmful information, drawing up documentation containing false information, lying to employees, customers or suppliers, but also exaggerating the scope of a given company's services or product features (Umphress et al., 2016; Dou et al., 2019).

A relatively large body of research has been conducted to determine what factors influence unethical pro-organisational behaviour. Particular studies have focused, among other things, on the impact of different types of leadership on the development of such behaviour (e.g. Miao et al., 2013; Graham, Ziegert, Capitano, 2015; Effelsberg, Solga, 2015; Tang, Li, 2022; Uymaz, Arslan, 2022), relational factors regarding the exchange processes between the leader and team members (Bryant, Merritt, 2021; Inam et al., 2021; Xiong et al., 2021), the problem of the mentality of people in managerial positions (Zhang et al., 2020; Zhan, Liu, 2022; Farasat, Azam, 2022), selected managerial factors (Xu, Lv, 2018; Ding, Liu, 2022), the role of selfishness, narcissism and greed (Graham et al., 2020; Shah et al., 2020; Tacke et al., 2023), as well as the importance of personal beliefs and personality traits (Clugston, Howell, Dorfman, 2000; Kong, 2016). Attention has been given to the moderating function of moral identity (Matherne, Litchfield, 2012; Johnson, Umphress, 2019; McCorvey, Woehr, 2022; Zonghua et al., 2022; Chen, M., Chen, C., 2023). Quite a few studies have been devoted to the role and importance of organisational identification (e.g. Umphress, Bingham, 2011; Effelsberg, Solga, 2015; Kong, 2016; Johnson, Umphress, 2019; Naseer et al., 2020; Graham et al., 2020; Schuh et al., 2021; Yang, Wei, Wu, 2021; Kelebek, Alniacik, 2022; Sharma, Mishra, Uppal, 2023; Holmes, Howard, 2023; Li, 2023). An interesting research trend has been the issues of moral decoupling (Fehr et al., 2019), moral disengagement (Schuh et al., 2021; Nguyen, Zhang, Morand, 2021; Yao et al., 2022), moral justification (Chen, M., Chen, C., 2023), psychological entitlement (Lee et al., 2019; Chen, M., Chen, C., Schminke, 2023; Jiang, Liang, Wang, 2023) and psychological embedding (Ghosh, 2017; Lee, Oh, Park, 2022).

Thus, as can be seen from the review, so far researchers have not devoted too much attention to managerial factors. Apart from HR systems and high-performance teams, the other identified factors – although very important to some extent – relate directly to management principles or a specific management philosophy followed by individual organisations. There is also rather little knowledge of the conditions in which product or service quality is lowered deliberately. The literature on the subject draws attention to the problem of monopolistic market positions (Mussa, Rosen, 1978), the importance of prices in trade (Leffler, 1982), the lack of knowledge of customer expectations and how quality can be achieved (Shetty, 1988), the inability of customers themselves to assess the quality of products and services (Liu et al., 2007), costing and marketing strategies (e.g. Balachander, Stock, 2009), the nature of distribution (Xu, 2009), the types of business activities (e.g. Pennerstorfer, Weiss, 2013) and the importance of compensatory attributes of services in relation to product quality (Guajardo et al., 2016).

In view of the above, the authors decide to make an attempt:

1. to identify the manifestations of unethical pro-organisational behaviour associated with the lowering of quality and the causes of such behaviour,
2. to establish how particular quality management principles may paradoxically enhance the drivers of unethical behaviour,
3. to determine what actions or measures can prevent unethical pro-organisational behaviour.

## **2. Method**

The primary purpose of this article is to identify the manifestations and causes of unethical pro-organisational behaviour related to the lowering of quality, as well as to propose measures that could prevent such behaviour.

The main research method used by the authors was a literature review. The review comprised the following stages: (1) selecting keywords (pro-organisational behaviour, unethical behaviour); (2) searching for papers containing the selected keywords in the following databases: Academic Search Ultimate, including Business Search Ultimate, Agricola, ERIC, Green File and Open Dissertation; (3) becoming familiar with the chosen publications; (4) reviewing the publications; (5) mind-mapping; (6) summarising the chosen publications, taking into account the objective of this paper; and (7) organising the collected research material. The applied procedure was in line with the general methodology for conducting research in management sciences (Easterby-Smith et al., 2015).

A total of 157 papers containing the key phrase “pro-organisational behaviour” underwent a review. This was followed by the selection and analysis of the literature that dealt with the lowering of quality (nine papers in total). The systematic literature review was extended to include grey literature review.

In the section on the causes, manifestations and ways of reducing the behaviour that constitutes the subject matter of this paper, the exemplification method was additionally used to illustrate and justify the formulated research premises (Kazmierska, 2018). This approach serves to enrich the explanation of the reality under study. The use of the exemplification method was based on the authors’ participation in quality management system audits conducted in business organisations of various types.

### **3. Results**

#### **3.1. Identification of manifestations of unethical pro-organisational behaviour aimed at the lowering of quality and their potential causes**

Unethical pro-organisational behaviour usually manifests itself in the destruction or deletion of uncomfortable information, preparation of documentation containing false information, falsification of vouchers or expense accounts, lies told to employees, customers or suppliers (Umphress, Bingham, 2011), destruction of incriminating files and records to protect an organisation’s reputation, manipulation of information to protect an organisation's image (Miao et al., 2013), theft, corruption, bribery (Shu, 2015), cheating of customers, prioritisation of profits over public safety, falsification of financial statements (Tian, Peterson, 2016), exaggeration of the scope of a company's services or the functionality of its products (Dou et al., 2019), distortion of the truth, as well as hiding of bad news or financial results from customers or the public (Zhang, Du, 2022).

In view of the above, the following question could be posed: Which of these or other manifestations are related to the lowering of quality and what causes them?

Firstly, one of these manifestations is the falsification of quality system documentation. The organisations that fail to update their quality management systems on an ongoing basis tend to complete their system documentation (e.g. internal quality audit reports) in a haphazard manner before an anticipated external audit (Bugdol, 2007). This noticeable problem is compounded by the current situation in the certification services market. With too many certification providers and a limited number of organisations seeking their services, the former are beginning to compete for the latter by reducing the quality of their services.

Secondly, there may be various types of misrepresentation of the functional characteristics of products or the scope of services offered (Dou et al., 2019). This can happen when an organisation prefers short-term profits over quality or in the conditions of strong competition.

Thirdly, unethical pro-organisational behaviour may also manifest itself in the concealment of quality errors that occur in individual processes. One reason for this is the fear of a reaction from superiors and an inappropriately designed bonus system that fails to take quality criteria into account (Bugdol, Jedynak, 2020). Organisations may hide their quality errors out of concern for their financial benefits. Such behavioural manifestations are more likely if quality assurance processes are not monitored or are inadequately monitored.

Fourthly, such unethical behaviour can manifest itself in the deliberate lowering of product quality by reducing the number of some components or adding ingredients of an inferior quality. In times of inflation, some companies that supply the market with both luxury products and products aimed at the average customer reduce the number of components needed to produce a particular product or its model. Moreover, they may claim that such measures are environmentally friendly. In fact, they exert more pressure on suppliers because they buy fewer parts but in larger batches (cf. Schumpeter, 2023).

Fifthly, another manifestation of said behaviour is providing customers with a completely different product (sometimes even one offered by competitors) under an organisation's own name. Such manipulations often require the cooperation of sales agents. In one such case, bound by a contract with a customer, a sales agent purchased products of a lower quality from a competitor and, after minor alterations, sold them to the customer under the trade mark of the company it represented. In this way, the agent succeeded in performing the contract, but its behaviour was unethical and even illegal, as the delivered products did not have the claimed quality characteristics. However, such behaviour would not have been possible without the knowledge and tacit consent of the company's employees responsible for sales operations.

Sixthly, unethical pro-organisational behaviour can also be manifested in establishing quality objectives that are very easy to achieve (cf. Bugdol, Jedynak, 2022). There are many reasons for this behaviour, but one of them is a faulty design of a remuneration system for managers which provides for a variable part of remuneration for the achievement of annually established objectives. Consequently, top management is not interested in pursuing ambitious objectives, but prefers ones that are secure and known in advance to be achievable, thus guaranteeing high remuneration.

### **3.2. Paradoxically, quality management principles reinforce the drivers of unethical behaviour**

In quality management, emphasis is put on the commitment of top management and employees, the use of statistical techniques of quality control, the improvement in the quality of work environment through education and training, as well as employee empowerment (cf. Tamimi, Gershon, 1995). It is assumed that an important element of these activities is the satisfaction of employees, support for their efforts and the setting of quality objectives for individual processes. Such activities are perfectly legitimate, but when they are not performed in line with the applicable principles or based on strong ethical values, various forms of unethical behaviour may occur. The table below shows selected examples of such situations.

**Table 1.**  
*Quality management and the risk of UPB occurrence*

Factor favouring UPB	Justification	Comments
Excessive identification	Involving employees in quality improvement processes, participating in decision-making and solving quality problems can lead to one's excessive identification with the organisation	Individuals who strongly identify themselves with their organisation are more likely to engage in UPB when they have strong positive beliefs about reciprocity and look forward to future reward from their organisation (Umphress, Bingham, Mitchell, 2010).
Organisational support of employees	In quality management, a lot of attention is given to supporting employees who care about quality improvement. The issue of providing such support is addressed in both the ISO 9001 standard and TQM policies.	A high level of organisational support may encourage UPB because employees have a sense of indebtedness to their organisation and look for ways to repay such debt (Yang, Wei, Wu, 2021; Griep et al., 2023).
Commitment	Treating employees well, rewarding them for quality improvements and appreciating their participation in solving quality problems can result in the development of an employee's emotional attachment to the organisation.	Individuals with lower levels of moral identity are more likely to engage in UPB, especially if they represent high levels of affective commitment (Matherne, Litchfield, 2012).
Job satisfaction	In quality management, employee satisfaction is a guarantor of external customer satisfaction.	Paradoxically, a strong sense of community and the resulting sense of satisfaction can contribute to the emergency of unethical pro-organisational behaviour (Zhang, 2020).
Pressure for results	In quality management, there can be strong pressure for results in the area of quality improvement.	It is assumed that such pressure tends to trigger UPB. This is contributed by moral justification, that is reconstructing harmful behaviour by associating it with worthwhile goals (Chen, M., Chen, C., 2023).

Source: the authors' own work based on the cited publications.

The Table 1 shows that improperly applied quality management principles can contribute to the development of UPB, especially in the conditions of excessive identification and the absence of adequate supervision, when moral values are compromised or when employees put personal gain before the well-being and interests of their organisation.

Pressure for quality performance can be particularly dangerous due to a lack of understanding of what a quality improvement process is. Such a process may not involve radical changes, but rather a continuous pursuit of gradually better results.

### 3.3. Actions that can prevent unethical pro-organisational behaviour

The conducted review of the literature on the subject shows that the scope of unethical pro-organisational behaviour can be reduced by means of the following measures: providing appropriate guidelines for pro-organisational behaviour (Xu, Lv, 2018), avoiding the negative effects of excessive concern about the welfare of employees, strengthening employees' moral identity, providing a positive ethical climate, suppressing selfishness and greed, as well as

promoting a culture of morality and ethical behaviour (Cheng, Wei, Lin, 2019; Qureshi, Ahmed, 2021; Inam et al., 2021; Kelebek, Alniacik, 2022; Kim, Lee, C., Lee, G., 2023).

Given the specificity of organisations oriented towards quality and the quality principles followed by them, particular attention should be paid to the following issues:

*a. Avoidance of excessive identification*

Identification alone does not necessarily lead to the development of UPB. Such behaviour emerges for other reasons. Members of an organisation will only approve of it if they regard it as morally acceptable (Schuh et al., 2021). In practice, therefore, it is recommended to follow the principles of positive discipline, which is lenient towards unethical acts as long as they result from incompetence rather than a lack of goodwill.

*b. Poorly understood organisational support*

A high level of organisational support must be linked to the support that leaders give to their team members. Attention should be paid to prevent the emergence of any debt of gratitude or violation of a concluded psychological contract (Griep et al., 2023). In practice, it is important that employees and management enter into a transparent contract governing their mutual expectations and needs. Hence, quality management systems emphasise the need to examine such needs and expectations, which later become requirements for employees.

*c. Combating excessive commitment*

There are many types of detrimental commitment. A case in point is anticipatory commitment, when certain activities are undertaken without the awareness of their need and potential benefits. But in practice, commitment can also be harmful in the case of a lower level of moral identity (Matherne, Litchfield, 2012). Employees with high levels of moral identity can act morally and are less likely to engage in unethical pro-organisational behaviour (Zonghua et al., 2022; Xu, Lv, 2018).

Shaping such an identity in management practice is difficult and sometimes unfeasible. The affective foundations of moral identity (e.g., empathy, guilt and shame) emerge early in life (Hardy, Carlo, 2011). However, efforts can be made to ensure that all manifestations of unethical and immoral behaviour are strongly denounced. Such action is taken in organisations that shape pro-environmental behaviour. A sense of shame and guilt is then aroused among those employees who do not comply with the rules currently in force.

*d. Conditions for using employee satisfaction*

Employee satisfaction does not equate to employee loyalty. Nor is there a direct connection between employee satisfaction and customer satisfaction. Nevertheless, it is generally accepted that employee satisfaction is a good thing and that is why so much importance is attached to this value in quality management. In practice, to ensure that satisfaction does not cause UPB, the process of maintaining satisfaction should be

linked to compliance with the principles contained in quality management systems. It is therefore important that employees receive information about the degree to which successive objectives are achieved. Such communication can have a motivating and satisfying effect.

Satisfaction, together with other values, forms a value system and this means that its perceived lack is caused by a lack of trust and fairness. The latter value constitutes the foundation of trust. In practice, the enemies of satisfaction include the same activities that harm the sense of fairness:

- annual employee appraisal systems (especially rankings),
- bonus systems based on employees' collective responsibility for achieving set objectives,
- different salaries for the same jobs,
- unequal treatment, favouritism.

*e.* Excessive pressure for results

Excessive pressure for results stems from greed, but it is conditioned by investment processes and other managerial factors. Huge bonuses earned by top management for meeting annual targets are the reason for building reward and appraisal systems oriented towards quickly reaching short-term goals. Acting under pressure from investors or owners, top management sets unrealistic and difficult objectives. This results in creative accounting methods and falsification of data (cf. Stanisławska, 2019).

In some organisations, employee assessment systems include individual goals. If these are unrealistic, both employees and their superiors tend to cheat (cf. Cohen, 2005). If performance undergoes rigorous assessment and an assessment process may result in either a dismissal or a financial reward, the propensity for UPB may increase. Thus, in order to prevent excessive pressure on performance, it would be necessary to dispense with numerical targets, which was recommended by E. Deming, and employee rankings, especially those linked to incentive systems. It is important that remuneration systems for top management should not provide for the payment of huge bonuses for the achievement of annual targets, especially if their achievement is attributed entirely to subordinate employees.

## 4. Discussion

The lowering of quality is caused by a number of factors, such a lack of knowledge (Shetty, 1988), a monopolist position (Mussa, Rosen, 1978), the dominant role of quantity (Leffer, 1982), the profitability of post-warranty services (Guajardo, Cohen, Netessine, 2016), different forms of sales (cf. Liu et al., 2007) and different forms of business activities (Balachander,



Stock, 2009). In some situations, what occurs is not so much unethical behaviour as behaviour that may raise ethical questions. In offering a product of a certain quality, it is important who determines the level of quality and the price, as well as who benefits from these decisions. If the seller, rather than the producer, sets the quality level, the latter's willingness to offer high quality products may be diminished under certain conditions. If the producer has influence over the price and the higher price increases their profits, they may tend to offer products of higher quality, provided that customers appreciate such quality (Xu, 2009).

Thus, it is worth noting that it is not only managerial factors, but also market conditions, or more broadly understood contextual conditions, that foster the occurrence of UPB.

Research also confirms that the individual principles and elements of TQM constitute a certain whole or system. The lack of a single element or action may cause a failure to achieve the intended effects in the form of quality improvement. Taking into account the factors of unethical behaviour, it can be clearly stated that the primary reason for the development of such behaviour is the lack of strong ethical organisational values such as trust and fairness.

Unfortunately, some badly designed employee assessment and remuneration systems contribute to the emergence of UPB. It is therefore difficult not to refer to the research of E. Deming, a vocal opponent of rankings, competition and numerical target setting (Deming, 1994).

## **5. Limitations**

Research limitations may arise from the adopted research method. The use of both a literature review and one's own experience significantly limit the range of obtained results.

The article does not address all quality principles. Those that are discussed are strongly linked to the identified causes of unethical behaviour.

It should also be borne in mind that the science of quality indicates many paradoxes. What is a cause of success in one setting may lead to the development of unethical behaviour in others.

## **6. Conclusion**

Manifestations of unethical pro-organisational behaviour aimed at the lowering of quality include falsifying system documentation, hiding quality errors that occur in individual processes, deliberately impairing product quality by reducing the quantity of particular components or replacing them with lower-quality substitutes, providing customers with

a completely different product, often one manufactured by a competitor, under the organisation's own name, as well as reducing quality objectives.

Paradoxically, the occurrence of UPB is fostered by excessive identification, affective commitment, organisational support resulting in a sense of indebtedness to the organisation, pressure for results and even satisfaction with one's job, when such satisfaction is not maintained by other organisational values.

The possible measures that could prevent unethical pro-organisational behaviour include the following: applying positive discipline, entering into transparent psychological contracts, abandoning annual employee appraisals, employee rankings and bonus systems whose results depend on employee cooperation, as well as the variable part of managers' remuneration.

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## ASSESSING THE EFFICIENCY OF HYBRID ENERGY FACILITIES FOR ELECTRIC VEHICLE CHARGING

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**Purpose:** The aim of the study is to evaluate the efficiency of using conventional energy facilities based on renewable energy sources to provide energy to battery swapping stations and charging stations for electric vehicles in one of the selected countries. As part of the work, the following tasks are solved:

- A mathematical model of charging stations or battery swapping stations, electrical installations based on renewable energy, and general energy facilities operating parallel to the electrical grid and autonomously is developed;
- A methodology has been developed, verifying the structures and parameters of energy facilities based on renewable energy sources for charging batteries of electric vehicles;
- The efficiency of using generation facilities based on renewable energy sources to battery charging stations in rural areas of such a large country is evaluated;
- The number of hybrid energy facilities based on renewable energy sources and charging stations is evaluated.

**Design/methodology/approach:** The examined power plant facilities serve electric vehicles in cities, recreation areas, industrial enterprises, and highways. Service types such as charging the battery and replacing discharged batteries of electric vehicles with pre-charged batteries are used at charging stations for electric vehicles. The efficiency of using conventional energy installations as part of charging stations is evaluated in regions with different climatic conditions.

**Findings:** The results show an increase in profit when participating in the ancillary service market.

**Originality/value:** In the following research paper were presented the optimization objective function that maximizes the profit.

**Keywords:** Hybrid Energy Facilities, Electric Vehicle Charging, Efficiency Assessment, Renewable Energy Integration, Energy Security.

**Category of the paper:** Research article.

## 1. Introduction

The number of cars polluting the atmosphere with exhaust gases is increasing every year (Wang et al., 2020). In Turkey, 17% (91 Mt of CO<sub>2</sub>e in 2021) of the total amount of pollutants entering the atmosphere comes from motor vehicles, and in large cities, this figure sometimes reaches 60% (Turkish Statistical Institute, 2022). New-generation hybrid electric vehicles (EV) and electric vehicles developed with today's technology are important options for reducing harmful emissions. Today, the electric vehicle market is developing rapidly in the world, and this process has also started in Turkey. According to September 2023 data, the five nations boasting the largest proportion of electric vehicle (EV) sales are Norway (all-electric vehicles made up 80% of passenger vehicle sales in 2022), Iceland (41%), Sweden (32%), the Netherlands (24%) and China (22%) (Joel, 2023). Just over 41.393 electric vehicles (0.3%) are used in Turkey (Turkish Statistical Institute, 2021). For the operation of electric vehicles, suitable grid charging stations are required, which today are represented by two types:

- Stations for swapping rechargeable batteries, where discharged batteries of electric vehicles are replaced with pre-charged rechargeable batteries at these stations (Ali et al., 2022),
- charging stations where rechargeable batteries of electric vehicles are recharged (Rajendran et al., 2021).

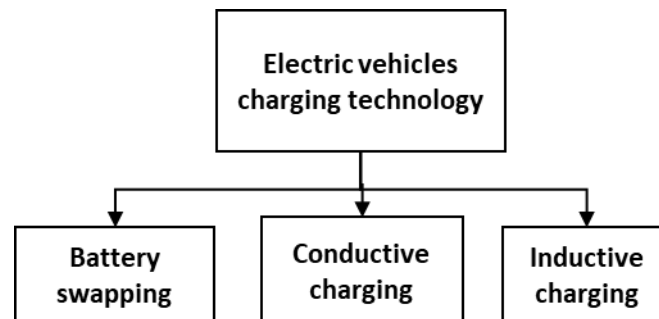
The network of charging stations has already become widespread around the world. According to 2023 data, there are more than 138,000 stations in the USA, more than 1.5 million in China, around 49,000 in Germany, and more than 8,800 stations of the first type in Turkey.

As the production and use of new-generation hybrid electric vehicles and electric vehicles begin to become widespread, the demand for electrical power is expected to increase in parallel. Nowadays, most charging stations and all battery swapping stations (Ali et al., 2022) operate with electricity obtained from the electrical grid. This means that the impact of reduced emissions due to switching to electric vehicles is offset by emissions from thermal power plants providing increased power for the new consumer. In order for the use of electric vehicles to have a significant environmental impact, it is recommended to provide energy to charging stations in energy production facilities based on renewable energy sources. In the structure of charging electric vehicles, energy facilities based on renewable energy sources contribute to:

- saving fossil fuels,
- improving the environmental situation in the regions,
- increasing the energy security and energy independence of the region.

It is known that there are very few charging stations in the world today that work only with renewable energy sources. Unfortunately, such stations are not yet available in Turkey. Therefore, it is quite important to evaluate the feasibility of building facility energy facilities based on renewable energy sources to power charging stations and battery swapping stations

(Ali et al., 2022). In this case study, it is assumed that the stations use conductive charging technology. In general, electric vehicle (EV) chargers can be categorized into two main groups: indoor and outdoor chargers, and further divided into one-way and two-way chargers. Figure 1 illustrates the various EV charging technologies, which are typically organized into the following three distinct categories.



**Figure 1.** Categories of technology related to EV charging.

## 2. Methods

The aim of the study is to evaluate the efficiency of using conventional energy facilities based on renewable energy sources to provide energy to battery swapping stations and charging stations for electric vehicles in Turkey. As part of the work, the following tasks are solved:

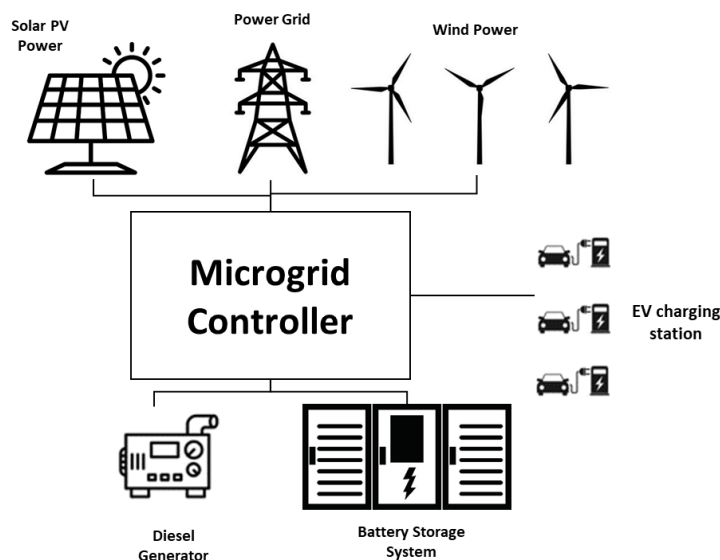
- A mathematical model of charging stations or battery swapping stations, electrical installations based on renewable energy, and general energy facilities operating parallel to the electrical grid and autonomously is developed;
- A methodology has been developed, verifying the structures and parameters of energy facilities based on renewable energy sources for charging batteries of electric vehicles;
- Turkey's surface area is 783,562 km<sup>2</sup>. The efficiency of using generation facilities based on renewable energy sources to battery charging stations in rural areas of such a large country is evaluated;
- The number of hybrid energy facilities based on renewable energy sources and charging stations is evaluated.

Above listed tasks are solved using the following methods:

1. The examined power plant facilities serve electric vehicles in cities, recreation areas, industrial enterprises, and highways.
2. Service types such as charging the battery and replacing discharged batteries of electric vehicles with pre-charged batteries are used at charging stations for electric vehicles.
3. The efficiency of using conventional energy installations as part of charging stations is evaluated in regions with different climatic conditions.

### 3. Mathematical model of hybrid energy systems

The research problem, which is the focus of this work, was solved using an improved mathematical model of integrated energy facilities consisting of power plants based on renewable energy sources and charging stations or battery swapping stations. In this case study, a microgrid makes effective use of information and communication technologies to oversee various components, such as electricity generators, energy storage systems, and electrical loads as depicted in Figure 2. To be more specific, a microgrid can be segmented into distinct subsystems, encompassing elements like wind power generators, photovoltaic (PV) solar power generators, distributed generators, battery energy storage systems, and electric vehicle (EV) charging stations. Solar-powered batteries serve as a valuable solution for meeting the unpredictable demands of grid electricity. These demands often involve rapid charging, discharging, and intermittent periods of full charge. The microgrid controller takes on the pivotal role of orchestrating the operations of all these subsystems and coordinating power distribution. Several research endeavors have been undertaken to explore methods associated with microgrids that incorporate EVs in conjunction with renewable energy sources.



**Figure 2.** Charging station interacting with renewable energy sources in microgrid.

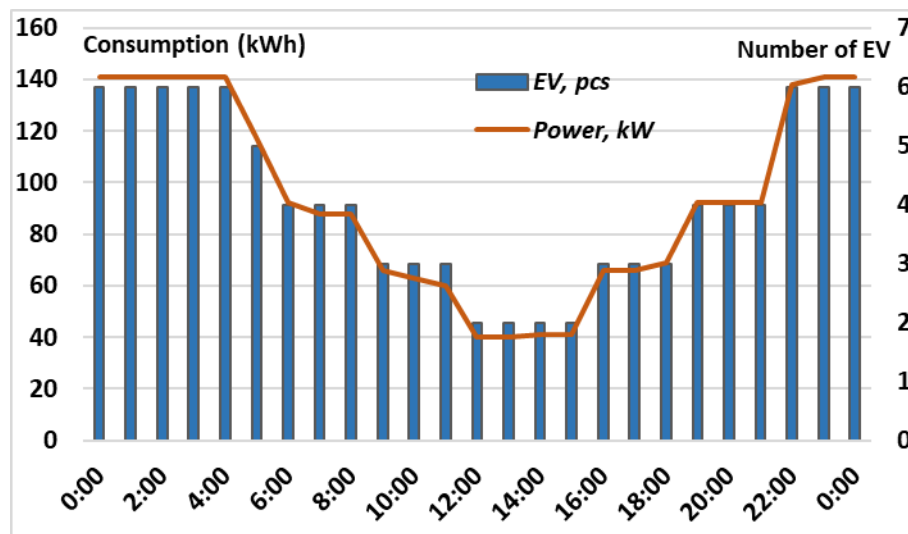
Since solar and wind resources are considered renewable energy sources in the study, the mathematical model of energy facilities includes the resource and technological models of wind energy and photovoltaic facilities. Resource models are represented by well-known data on solar and wind energy, while technical models are represented by the known dependence of the generation of power plants on the mode of energy received from renewable energy sources.

Analysis of scientific studies (Al Wahedi, Bicer, 2022; Lee et al., 2015; Li et al., 2022; Luo et al., 2018; Marinescu, 2022) on charging electric vehicles has shown that modeling such energy consumers as charging stations has not received enough attention in the world to date. In this study, various energy consumers are modeled such as day/night stations, battery

swapping stations serving the taxi and factory fleet, battery swap stations serving the vehicle fleet in the area, and autonomous battery swapping stations. The difference between such stations is characterized by different work schedules, as well as some indicators of the degree of controllability by the station owner.

- Daytime charging stations are located in car parks, near train stations, shopping areas, sports centers, etc., where demand is highest during daylight hours;
- The location of the night charging station in public or private parking lots located near residential buildings and where the demand for recharging vehicles is highest at night;
- There are charging stations at gas stations, and peak demand occurs during daylight hours;
- Battery swapping station serving the fleet of taxi companies and factories;
- Battery replacement station serving the vehicle fleet in the shopping mall parking area.

Modeling of charging and battery replacement stations is carried out by taking into account the time-of-day dependence of the demand for charging or replacing the battery of electric vehicles and the daily electricity consumption schedules by these stations. An example of the time dependence of demand-simulating charging stations is shown in Figure 3. The electric vehicle charging station's own internal needs such as lighting and heating are also included.



**Figure 3.** Daily electricity consumption of the charging station and the dependence of charging of electric vehicles on the time of day.

Mathematically, the model of energy facilities includes the constraints and conditions that must be met during the operation process. Thus, the operating mode for energy facilities, including charging stations, is described in a simplified form depending on the number of batteries ( $nrech_{bat}$ ).

Here we are talking about standard rechargeable batteries that accumulate energy from renewable energy sources and later supply to facilities and charge electric vehicles.

Two operating mode options are possible in energy plants with charging stations:

1. When batteries are not included in energy facilities, ( $nrech_{bat} = 0$ ). Then the power consumed by the electrical grid is determined as follows:

$$P_c(t) = l_{fac}(t) - p_{ren}(t) \cdot \eta_{eq} \text{ at } \frac{l_{fac}(t)}{n_{inv}} > P_c(t) \cdot \eta_{con} \quad (1)$$

where:

$P_c(t)$  – consumed power from grid (kWh),

$l_{fac}(t)$  – the load of facilities (kWh),

$p_{ren}(t)$  – generated power from renewable sources (kWh),

$\eta_{eq}$  – total efficiency (%),

$n_{inv}$  – efficiency of inverter (%),

$\eta_{con}$  – efficiency of converter (%).

2. In cases where batteries are located in centralized energy facilities, two options are taken into account when determining the power consumed by the network:

If the generated power of renewable energy sources is not enough to ensure the power balance, electricity is consumed from the grid.

$$P_c(t) = l_{fac}(t) - (p_{ren}(t) \cdot \eta_{conv} + p_{bat}(t)) \cdot \eta_{inv} \text{ at } \frac{l_{fac}(t)}{n_{inv}} - P_c(t) \cdot \eta_{con} > p_{bat}(t) \quad (2)$$

where  $p_{bat}(t)$  – battery power (kW).

For battery swapping stations, the operating mode is also described in a simplified form depending on the number of batteries in the power plants. In this case, electric vehicle batteries serve as energy accumulators for renewable energy sources. In the future, some of these batteries will be used to provide energy to power plants, and some will be installed in electric vehicles to replace discharged batteries. In this case, the power consumed for energy facilities at battery renewal stations will be as follows:

$$P_c(t) = l_{fac}(t) - p_{ren}(t) \cdot \eta_{con} \text{ at } l_{fac}(t) > P_c(t) \cdot \eta_{con} \quad (3)$$

In this case, the minimum permissible number of fully charged electric vehicle batteries that must be available for battery replacement is taken into account. If the number of batteries is greater than the minimum permissible number of fully charged electric vehicle batteries, the following options are possible for powering grid-connected energy facilities:

- The generation of renewable energy sources is not sufficient to both ensure power balance and provide power to the electric vehicle power supply system

$$l_{fac}(t) > p_{ren}(t) \cdot \eta_{conv} \quad (4)$$

$$p_{cap}(t) > p_{ren}(t) \cdot \eta_{conv} \quad (5)$$

where:

$p_{cap}(t)$  – power capacity of hybrid energy facilities (kW),

$p_c(t) = 0$  where the number of fully charged batteries is sufficient to cover both the battery replacement demand and the nominal capacity of the hybrid energy facilities.

If the number of charged batteries is not sufficient to power the capacity of the facility, the missing part of the power supply is consumed from the grid.

$$p_c(t) = p_{cap}(t) - p_{ren}(t) \cdot \eta_{conv} - dis_{bat} \cdot ch_{le} - hyb_{bat} \cdot p_{bat} \quad (6)$$

where:

$dis_{bat}$  – number of discharged batteries, (pcs.),

$ch_{le}$  – current charge level of the battery, (kW),

$hyb_{bat}$  – the number of batteries that can be used to supply power; to hybrid energy facilities, (pcs.),

$p_{bat}$  – the total power of the battery, (kW).

- When the number of fully charged batteries is not sufficient to meet the demand for battery replacement, the power required not only for the capacity of the plant but also to recharge the required number of batteries is consumed from the network.

$$p_c(t) = p_{cap}(t) - p_{ren}(t) \cdot \eta_{conv} - dis_{bat} \cdot ch_{le} - nrech_{bat} \cdot p_{bat} \quad (7)$$

where  $nrech_{bat}$  – number of rechargeable batteries, pcs.

When the generated energy from renewable sources is sufficient to ensure the capacity of the facility or to achieve power balance.

$$l_{fac}(t) > p_{ren}(t) \cdot \eta_{eq} \quad (8)$$

- if the number of charged batteries is sufficient to satisfy the demand for battery replacement,  $p_c(t) = 0$ .
- if the number of fully charged batteries is not enough to satisfy the demand for battery replacement, then excess power from renewable energy sources, and/or power from the grid, is used to recharge the discharged batteries:

$$p_c(t) = p_{cap}(t) - p_{ren}(t) \cdot \eta_{conv} + rech_{bat} \cdot p_{bat} \quad (9)$$

- The battery's state of charge (SOC), represented in the following model, must remain within its minimum and maximum thresholds and should attain a specified target within a designated timeframe.

$$SOC_i(t) = SOC_i(t-1) + (S_{ch}\eta_{ch})P_{EV} \quad (10)$$

$$SOC_{min,i} \leq SOC(t-1) \leq SOC_{max,i} \quad (11)$$

$$SOC(t_{d,i}) \geq SOC_{d,i} \quad (12)$$

where:

$\eta_{ch}$  - the efficiency of the charger,

$S_{ch}$  - an indicator binary state variable that equals to 1 when charging and 0 otherwise,

$SOC_{d,i}$  - desired value,

$t_{d,i}$  - certain time.

The development of hybrid energy facilities based on renewable energy sources and charging stations is a critical step towards achieving sustainable and clean energy systems. To conduct a feasibility study for such facilities, it's essential to consider various models and their operating conditions. In summary, a feasibility study for hybrid energy facilities based on renewable energy sources and charging stations should encompass various models, data sources, and considerations to evaluate technical, financial, environmental, and regulatory aspects. This comprehensive analysis will help stakeholders make informed decisions about the viability of such projects.

## 4. Results

In this study, the equipment shown in Table 1 is selected for a numerical analysis of the structure and parameters of hybrid power facilities.

**Table 1.**

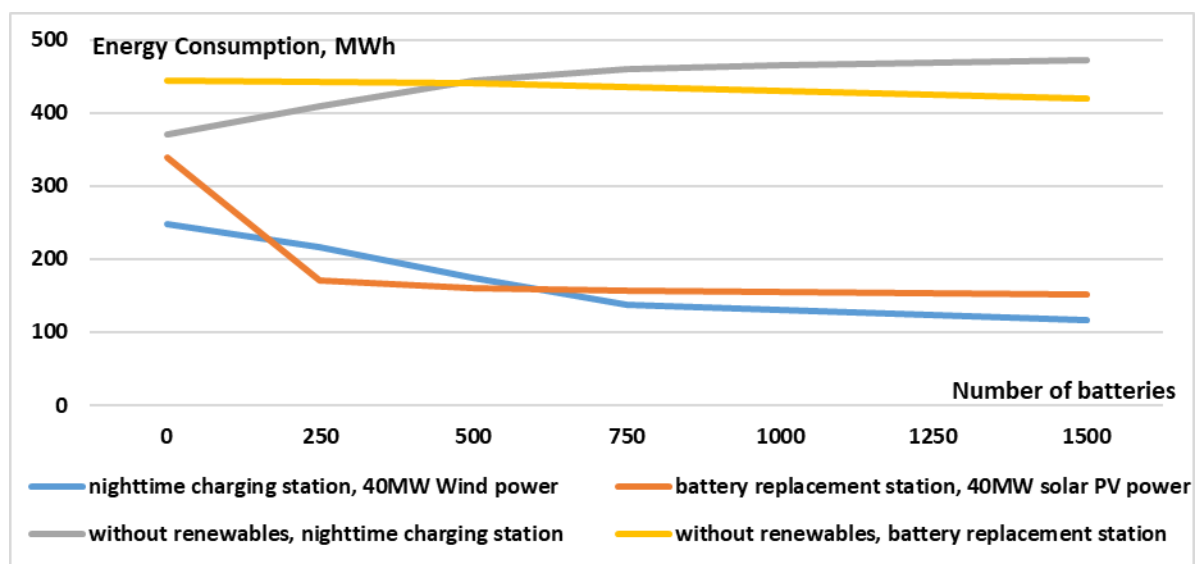
*Equipment included in the typical versions of the hybrid energy facility*

<b>PV Manufacturer number</b>	<b>Sunpays Mono 9BB</b>	<b>Sunpays Mono 11BB</b>
Nominal Power	450kW	550kW
Module efficiency	20.7%	21.3%
<b>Diesel Generator Manufacturer number</b>	<b>Aksa AP 500</b>	<b>Aksa AVP 350</b>
Standby Rating	400kW	288kW
Fuel Cons. Prime With %100 Load	95lt/hr	63,5lt/hr
<b>Wind turbine Manufacturer number</b>	<b>Hummer H100KW</b>	<b>DeimosWind DT 2169</b>
Rated power	100kW	60kW
Cut-in wind speed	2,5 m/s	3,2m/s
Rated wind speed	10m/s	8,5m/s
Cut-out wind speed	20 m/s	25m/s
<b>Battery Manufacturer number</b>	<b>SMART ESS 500</b>	<b>SMART ESS 250</b>
Output Power	500 kW	250kW
Capacity	280AH	280AH
Cycle lifetime at 30% D.O.D.	16000 times	16000 times
<b>EV model</b>	<b>Togg T10X</b>	<b>Tesla Model Y</b>
Battery capacity	88,5 kWh	78.1 kWh
Battery range	523 km	415 km



The developed algorithm provides the opportunity to evaluate different options for the composition of the equipment of hybrid energy plants for different regions of the case study. The results of the calculations are presented in Figures 5 and 6. The results describe the analysis of the relationships between the composition and characteristics of hybrid energy systems and their efficiency, especially in terms of electricity consumption from the power grid and electricity production from the diesel power plant.

This study allows us to determine the optimal amount and type of equipment to minimize diesel fuel consumption or achieve maximum savings when using a diesel power plant as a backup power source instead of the traditional electricity grid. These results are important for the development and optimization of hybrid energy systems that can be effective in situations where access to electricity is limited or electricity supply from the main grid is unstable. They can help reduce fuel costs and increase the efficiency of energy systems.



**Figure 5.** Energy consumed from the grid per year.

The obtained results show that with fuel consumption per 100km drive of 7-10 liter and power consumption of Togg T10X and Tesla Model Y electric vehicles per 100 km run of 16.9 and 14.5 kWh, respectively, the cost of charging an electric car is in some cases less than the cost of refueling a car.

Economic efficiency is evaluated by comparing the cost of recharging the battery of an electric car with the cost of refueling a car of the same class with gasoline according to the results of calculations of operating modes of hybrid energy facilities.

To evaluate the comparative economic efficiency of charging electric vehicles from hybrid energy installations based on renewable energy sources compared to refueling vehicles with gasoline, the electricity tariff sold to consumers was changed during the calculations.

## 5. Conclusions

This study addresses the pressing issue of transitioning to cleaner energy sources in the face of rising pollution from conventional vehicles. The research sheds light on the evolving landscape of electric vehicle adoption and charging infrastructure, highlighting the growing need for sustainable energy solutions. The results obtained from this study can be listed as follows:

- The mathematical models and analyses presented in this study provide a comprehensive framework for evaluating the efficiency of hybrid energy facilities and their potential impact on reducing diesel fuel consumption in electric vehicle charging stations or battery swapping stations. These insights are valuable for decision-makers, especially in regions with limited access to stable grid electricity, as they can help optimize energy systems and minimize costs.
- The study on the influence of the composition and parameters of hybrid energy installations on their operating modes has shown that grid-connected hybrid energy installations are most effective for charging stations where the highest energy consumption occurs in the evening and at night.
- In grid-connected facilities; hybrid energy facilities based on wind power plants and a charging station or battery swapping station are effective at an average annual wind speed of more than 4 m/s; solar photovoltaic stations and hybrid energy facilities with battery replacement station are effective with an average annual solar radiation of more than 680 kWh/m<sup>2</sup>.
- In facilities not connected to the grid, it is more effective than similar hybrid energy facilities with diesel power plants, with an average annual wind speed of 5 m/s.
- The developed recommendations for determining the optimal structure of typical hybrid energy facilities based on charging stations and renewable energy sources allow for assessing the efficiency of using such hybrid energy facilities in various regions of Turkey. This assessment is based on the assignment of specific values of gross renewable energy potential and the conditions for utilizing hybrid energy facilities for each respective area in Turkey.
- However, it is evident that there is a scarcity of charging stations globally that exclusively rely on renewable energy sources, a gap that also exists in Turkey. Therefore, the study underscores the need to explore the feasibility of constructing complex energy systems based on renewables to support these charging stations. Such initiatives hold the potential to not only decrease the carbon footprint but also enhance energy independence and security.

The presented research focused on assessing the efficiency of the use of conventional energy facilities, based on renewable energy sources, to power battery replacement stations and vehicle charging stations electrical in one of the selected countries. Against the background of scientific considerations, the question must be answered whether such a model of behavior can be replicated in other countries, including Poland? According to researchers, the adoption of this vision should certainly be verified with broader analyses, from an interdisciplinary perspective, including: taking into account the number of vehicles and charging stations, the management of cable and transmission infrastructure and the energy efficiency of renewable energy installations in various urban and rural areas.

To sum up, the presented research on the assessment of the efficiency of the use of conventional energy facilities, based on renewable energy sources, to power battery replacement stations and vehicle charging stations electricity in one of the selected countries do not fully cover the essence of this issue. The market will certainly take care of their verification, indicating whether the presented solutions will be implemented in practice in the near future.

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## SIMULATION MODELING OF EVACUATION IN DEVELOPING AN EMERGENCY PREPAREDNESS PLAN

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**Purpose:** The purpose of the research was to demonstrate the feasibility of using an application for modeling the evacuation of people, for the decision support process during the development of emergency preparedness plans requiring the evacuation of products from the warehouse.

**Design/methodology/approach:** Pathfinder software was used during the analysis. It allowed mapping the space of an example warehouse and simulating the movement of internal transport (forklifts) in it. The study was conducted for sample scenarios of events requiring evacuation.

**Findings:** Simulations of product evacuation in the warehouse made it possible to determine evacuation times. A categorization of production by value was made, establishing different sequences of their removal from the warehouse. This made it possible to optimize the location of products in the warehouse and the actions of forklift operators during evacuation. These findings can be incorporated into the emergency response plan required in safety management systems.

**Research limitations/implications:** The results of the study refer to a case study company, and the scenarios are specific to the company. However, they exemplify a universal approach to the possibility of supporting emergency planning requiring the evacuation of property.

**Practical implications:** The paper presents a procedure scheme for planning emergency preparedness using evacuation simulation modeling. An example of using human evacuation modeling software to simulate the evacuation of products from a warehouse is presented.

**Originality/value:** The article includes a unique example of using a human evacuation simulation modeling application to model the evacuation of pallets of products in a warehouse.

Keywords: simulation modeling, emergency situations, safety management.

**Category of the paper:** research paper, case study.

### 1. Introduction

Methods of preparing for emergency situations in companies are part of the guidelines for implementing occupational safety management systems (Dahlke, Idczak, 2021; Dahlke, 2022; PN-ISO 45001; ISRS; OHSAS 18001; PN-N-18001; SCC 2004/4; Pearse W., 2002; Redinger

C.F., Levine S.P., 1998). The implementation of emergency procedures and instructions is aimed at reducing the consequences and costs of incidents (Dahlke, Idczak, 2021). One of the most important elements of the aforementioned guidelines is an emergency response plan (Dahlke, 2022; <https://www.epa.gov/rmp>; OHSAS 18001:2007; PN-ISO 45001:2018-06).

Emergency situations cause or can cause losses, which in the literature are divided into four categories (PEME) (Lelo, Purba, 2018):

- People.
- Equipment.
- Materials.
- Environment.

According to the EPA (United States Environmental Protection Agency), the Hazardous Release Risk Management Program (RMP, Article 112r) requires hazard assessments and emergency response programs. It includes (<https://www.epa.gov/rmp>):

- hazard assessment that details the potential consequences of an accidental release, the history of accidents over the past five years, and an assessment of worst-case and alternative release scenarios,
- prevention program including precautions and maintenance, monitoring and training measures for workers, and
- emergency response program, which specifies emergency health care, means of training employees, and procedures for informing the public and response institutions (e.g., fire departments) in the event of an emergency.

The most important hazards in industrial plants include (Mannan, 2012):

- fires,
- explosions,
- release of toxic chemicals.

Expansion of a fire is a very rapid phenomenon and requires immediate intervention. In fire zones that border the zones in which the fire occurred, it is possible to take a loss-limiting action, which is the evacuation of property. You can prepare for it by planning:

- evacuation routes and transportation means,
- fire protection of transport routes and product storage areas,
- the sequence of evacuation based on criteria valuing property,
- training of persons responsible for evacuation.

The property evacuation plan can be supported by the use of computer simulation tools adapted mainly for modeling the conditions of occupant evacuation. Many computer softwares have been developed for this purpose. As examples can be mentioned: AnyLogic PLE, CrowdMaster, Evacs, EvacSim, Building Exodus maritime Exodus, Legion Simulator, Massive, MassMotion, Panic, Pathfinder, Pedestrian Dynamics, Simulex, Simwalk, Social Distances, Steps, Wayout and many others (Kuligowski, 2013; Dahlke, 2020). They have been

prepared mainly for modeling the behavior of people in buildings, but they can also be applied to transportation modes or areas outside buildings (Abdelgawad, Abdulhai, 2012; Gudowski, Wąs, 2006; Hedo, Martinez-Val, 2011; Ku et al., 2020; Melis et al., 2020; Wang et al., 2020).

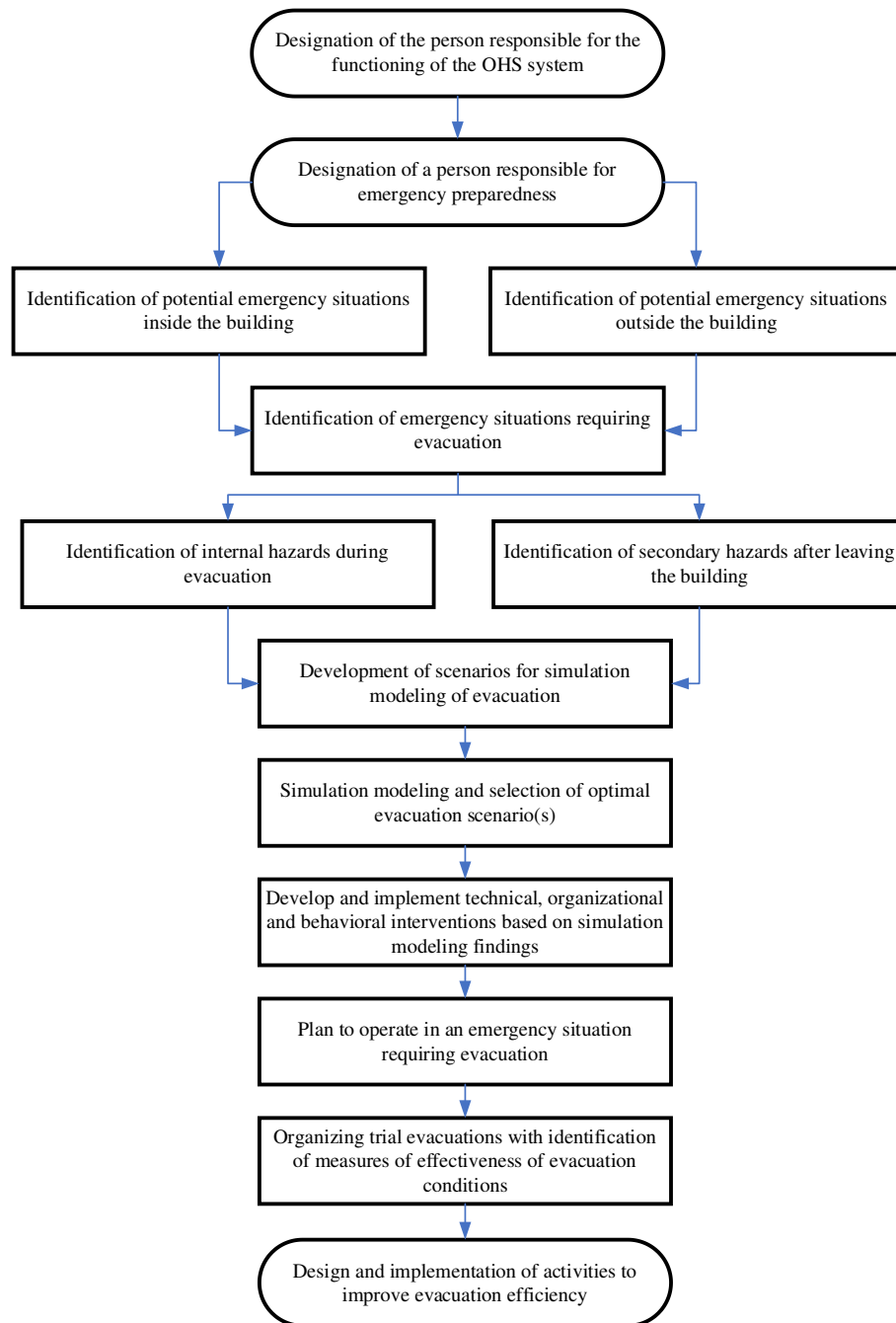
Based on an analysis of the literature, it can be assumed that few publications are concerned for modeling the evacuation of products from the warehouse. Some of the papers in the field of logistics address the problem of logistics in crisis management (Grocki, 2010; Detzer et al., 2016), determining the general requirements for satisfying needs and flows of products. Evacuation is only possible if it does not require a risk of life and health of employees. The most probable scenarios involve taking action when an accident requiring evacuation develops, for example, in the vicinity of the warehouse building (e.g., an adjacent fire zone when the cause of evacuation is a fire). Evacuation planning should estimate the critical evacuation time (Siam et al., 2022) or, in the case of fire, the critical fire time (Hulida et al., 2019). In the case of hazardous events in warehouses, the most common concern is the evacuation behavior of people in the company/building (Joo et al., 2013; Kosinski, Grabowski, 2010; Shaik et al., 2019) or in the company's surroundings (Ikeda, 1982). Among the basic criteria for optimizing product placement in a warehouse are economic objectives (space usage, cost and transportation time) and environmental objectives (CO<sub>2</sub> emissions of transportation means) (Sadeghi et al., 2024; Mrówczyńska, Śladkowski, 2013; Sikora et al., 2015; Félix-Cigalat, Domingo, 2023).

The modeling of evacuation conditions using computer softwares is a widely used activity to support decision-making in both the design and correction phases of both buildings and organizational systems for safety.

The article presents a method of decision support during property evacuation planning using the Pathfinder application. The analysis was carried out on the example of a warehouse.

## 2. Methods

The process of modeling warehouse evacuation conditions using Pathfinder softwear requires the introduction of activities similar to modeling the evacuation of people. One of the most important planning steps is the preparation of accident scenarios for the example under consideration (**Figure 1**). Since each facility being modeled has its own unique characteristics, it is necessary to gather basic information.



**Figure 1.** Diagram of the structure of emergency preparedness activities requiring evacuation, taking into account the results of evacuation simulation modeling (OHS – Occupational Health and Safety).

Source: Dahlke, Idczak, 2021.

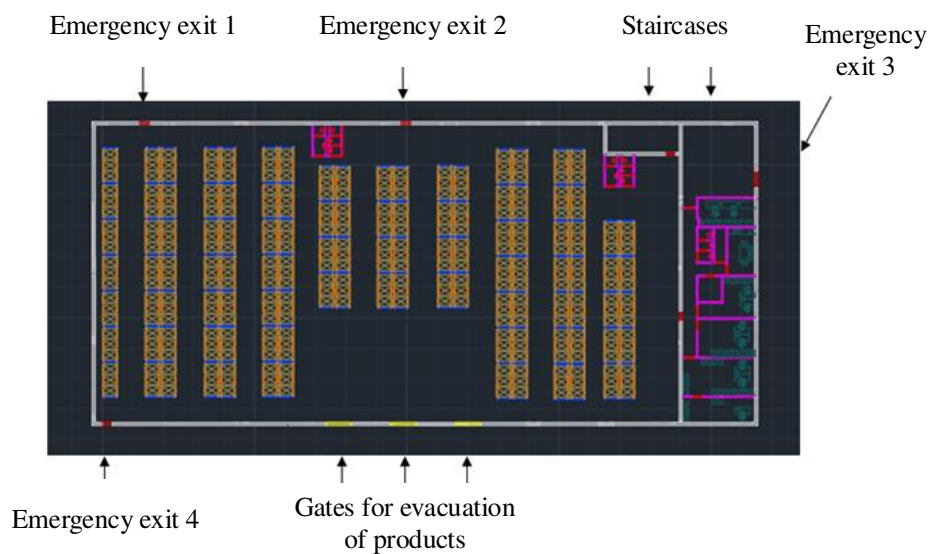
The object to be analyzed in detail is a building with a warehouse-office-social function, which is a back office of an enterprise engaged in the distribution of products to stores, supermarkets, and wholesalers both in Poland and abroad. The building consists of a three-story social-office part and a one-story warehouse part, which is a high-storage logistics facility, where the assortment is stored by pallet, and a given pallet contains only one group of products. It was assumed that the assortment in the warehouse is divided and stored according to their functionality. Pallets on the racks are stored in such a way that the heaviest ones are on the



lowest level, while the lightest ones are as high as possible - this is due, among other things, to the technical limitations of transport trucks, but also to ensure safe working conditions for employees. The warehouse section is serviced by 6 Jungheinrich ETV 110/112 reach trucks, 4 PRA 2500/11150 G/PT hand pallet trucks and 3 LION-TRUCK PLUS electric pallet trucks.

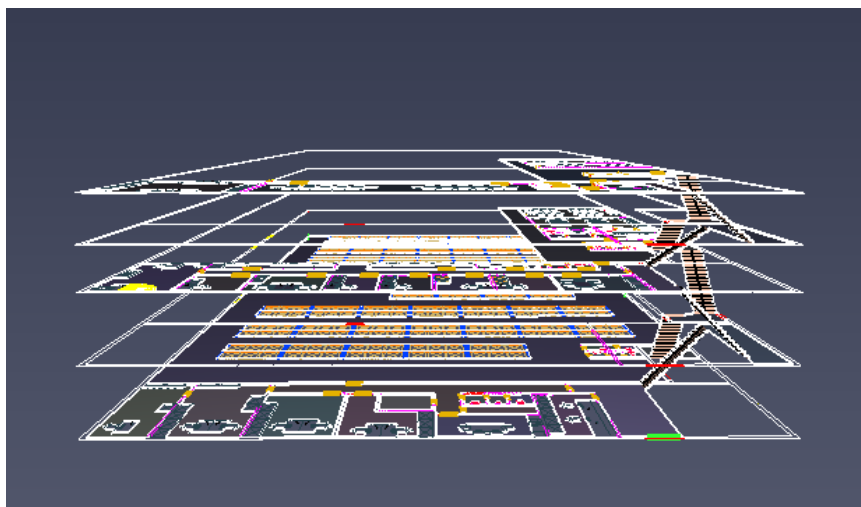
The total height of the building was about 15 m, and the first floor area was equal to 1995 m<sup>2</sup>. The building was equipped with fire protection devices, i.e. a fire alarm system, an audible warning system, a fire power switch, a gravitational smoke removal system, fire dampers and an external and internal hydrant system.

In mapping the building, drawings of top views of each room were first prepared in AutoCAD and exported to Pathfinder (Figure 3, Figure 4). Shelving in the storage area, office furnishings (desks, chairs and cabinets) were plotted on the floor plans (**Figure 2**).



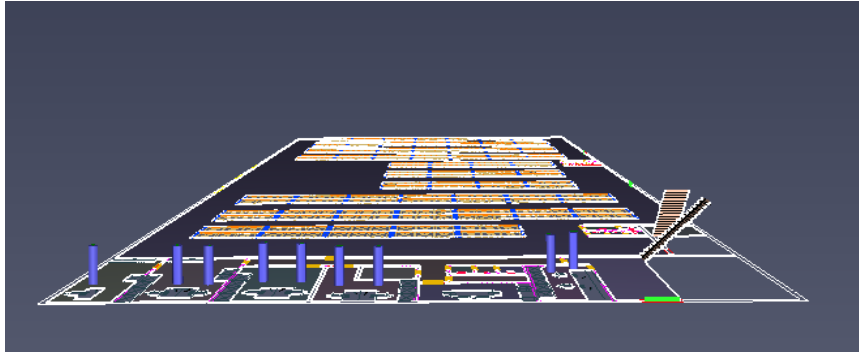
**Figure 2.** First floor plan of the surveyed building.

Source: Sopoćko, 2019.



**Figure 3.** A rendering of the building including the warehouse in Pathfinder software.

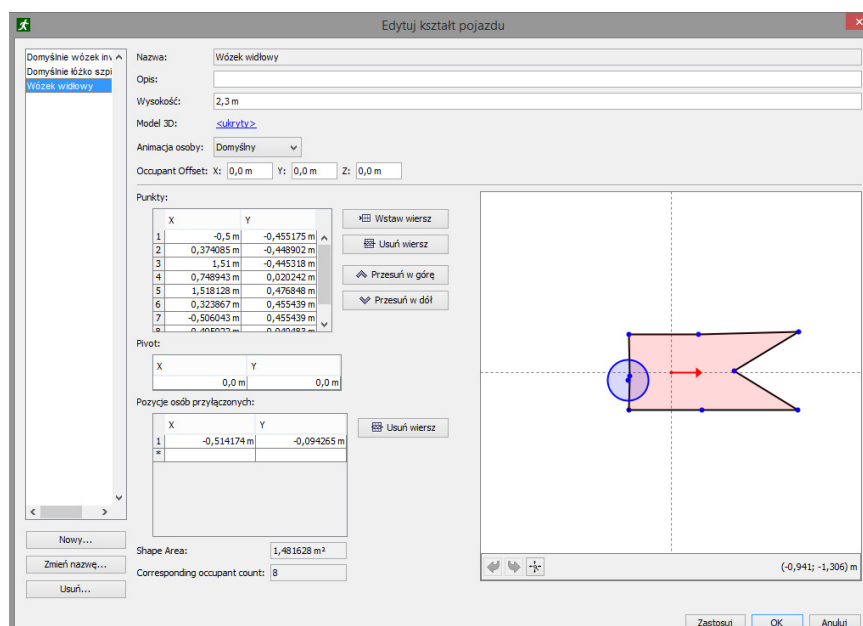
Source: Sopoćko, 2019.



**Figure 4.** First floor plan after occupants input made in Pathfinder software.

Source: Sopoćko, 2019.

In a similar approach to the evacuation of people, it is necessary to show the details of objects moving in the evacuation area, which are the forklifts (**Figure 5**). Their task will be to move products from a rack to a designated storage area. During the simulation, the forklift takes the shape of a solid, or more precisely, a prism. In a similar way to the evacuated occupants, they are assigned behaviors that will correspond to the developed event scenarios.



**Figure 5.** Forklift model made in Pathfinder software.

Source: Sopoćko, 2019.

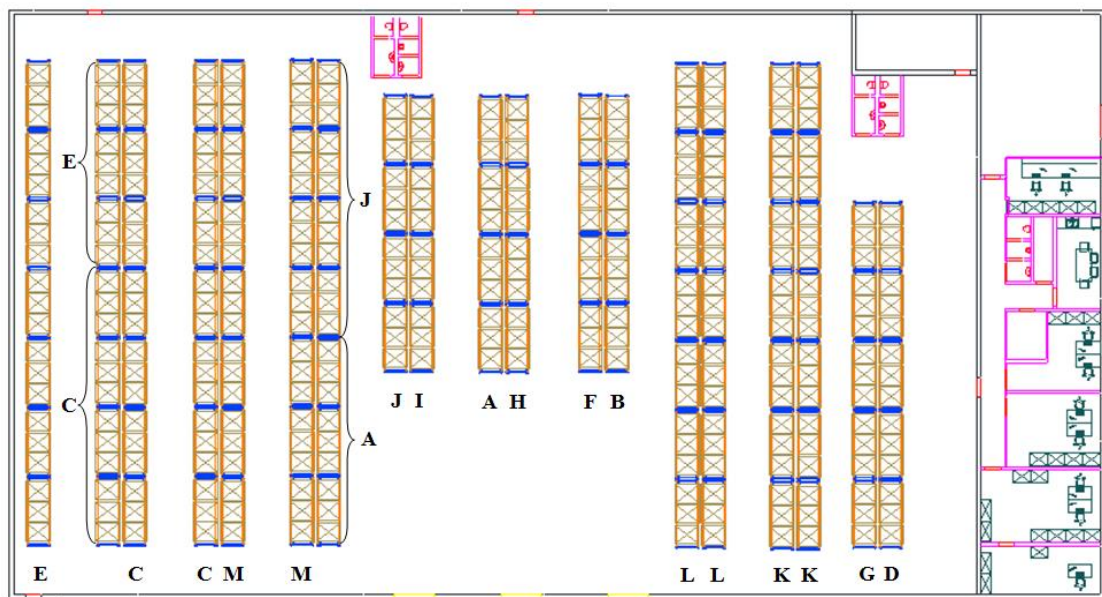
The figure below (**Figure 6**) shows the distribution of assortment on each rack. When optimizing the order of pallets evacuation with products, it is necessary to introduce weight criteria, for example, the value of products on a pallet. Products were assigned value classes according to a five-point scale (Table 1):

- 1 – Value of product up to 80 PLN.
- 2 – Value of product up to 120 PLN.
- 3 – Value of product up to 170 PLN.
- 4 – Value of product up to 200 PLN.
- 5 – Value of product up to 200 PLN.

**Table 1.***Type and evaluation of the assortment's value*

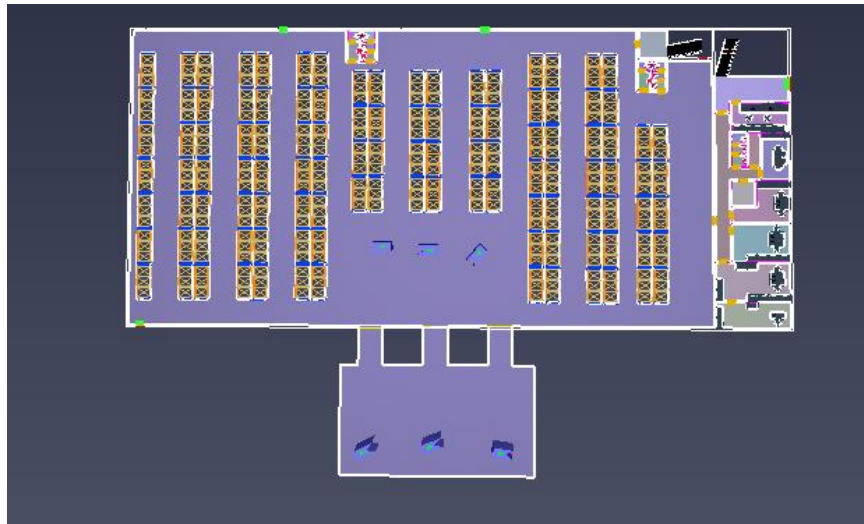
Marking the storage area	Type of assortment	Value assessment
<b>1</b>	<b>2</b>	<b>3</b>
<b>A</b>	Assortment 1	2
<b>B</b>	Assortment 2	1
<b>C</b>	Assortment 3	5
<b>D</b>	Assortment 4	2
<b>E</b>	Assortment 5	4
<b>F</b>	Assortment 6	2
<b>G</b>	Assortment 7	3
<b>H</b>	Assortment 8	2
<b>I</b>	Assortment 9	2
<b>J</b>	Assortment 10	3
<b>K</b>	Assortment 11	3
<b>L</b>	Assortment 12	2
<b>M</b>	Assortment 13	3

Source: Sopoćko, 2019.

**Figure 6.** Distribution of individual assortment groups.

Source: Sopoćko, 2019.

Pallets of products were taken outside the warehouse by forklifts. Mapping this activity required drawing in additional space outside the warehouse building (**Figure 7**).



**Figure 7.** Building with additional space for product storage and forklifts.

Source: Sopoćko, 2019.

After preparing a model of the building and transport equipment, it is necessary to prepare scenarios of events requiring and affecting evacuation. They are included in Table 2.

**Table 2.**

*List of scenarios for modeling evacuation of property from a warehouse*

Scenario No.	Characteristics of the incident requiring evacuation
<b>Scenario 1</b>	Evacuation from a warehouse rack containing L-type products by two forklifts inside and two forklifts outside the warehouse when two sectional gates are open.
<b>Scenario 2</b>	Evacuation from a storage rack containing Group L products by two forklifts that transport the product range directly to the outside, when two sectional gates are open.
<b>Scenario 3</b>	Evacuation of products by two forklifts from a rack containing Group C products in a warehouse. The forklifts transport the assortment directly to the outside through the open two sectional gates.
<b>Scenario 4</b>	Evacuation of products from a rack containing Group C products in a warehouse. Two forklifts work inside and two forklifts outside the warehouse. Two sectional gates are open.
<b>Scenario 5</b>	Evacuation of products by three forklifts using three sectional gates. The forklifts evacuate products directly to the outside. Imposed evacuation time - 2 minutes.
<b>Scenario 6</b>	Evacuation of products assuming three forklifts working inside and three outside the warehouse. Three sectional gates will be used. Imposed evacuation time - 2 minutes.

Source: Sopoćko, 2019.

Mapping the accepted scenarios required specifying "behaviors" in Pathfinder's software enabled:

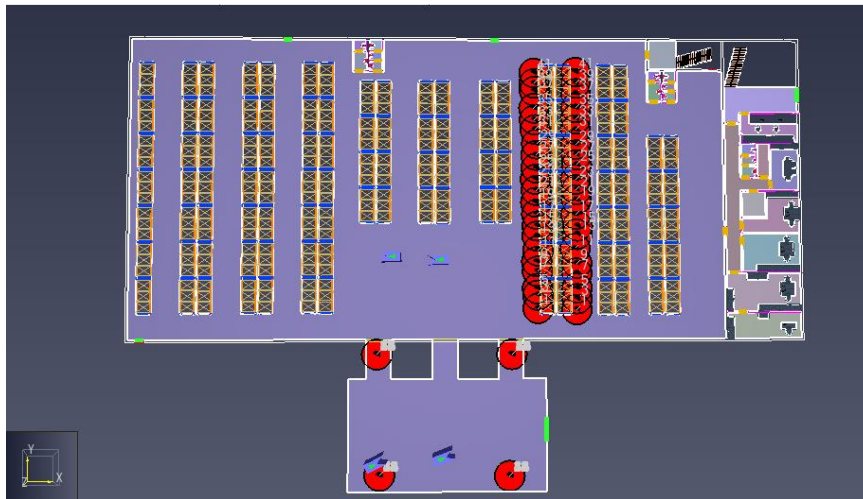
- indicating the location of the points to which the transport forklifts were to be moved (inside and outside the warehouse),
- forcing a stop when a pallet with products is pulled off the rack,
- forcing a stop when pallet with products is put down.

The forklift's standstill time was determined by measurements during observation of the work process. The speed of the forklifts was about 2.78 m/s, that is, approximately 10 km/h. After the evacuation of property was completed, each forklift left the warehouse area through the additional evacuation gate.

### 3. Results

#### 3.1. Scenario 1

In Scenario 1, it was assumed that Group L products would be evacuated. It was established that two forklifts operate inside and two outside the warehouse. The forklifts working inside the warehouse retrieve the product range and then transport it just outside the sectional gate. The standstill time for the forklift working inside is 10 seconds to remove a pallet from the rack and five seconds to put the pallet back in a specific place. Equipment working outside pulls up to where the pallets have been deposited by the warehouse forklifts, and then transports them directly to a safety location. The standstill time for external forklifts is assumed to be the same as for those working inside (Figure 8).



**Figure 8.** Evacuation of products - Scenario 1. Red circles mark points of movement of forklifts.

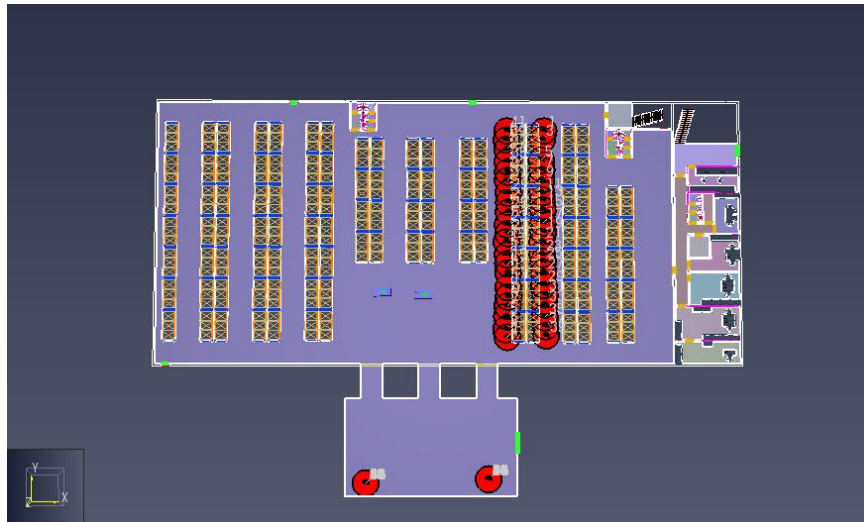
Source: Sopoćko, 2019.

The evacuation time for the established scenario was 913 seconds. During the simulation, it was assumed that each of the operating forklifts would follow a specific path, so the property evacuation process itself went quite smoothly - there were no collisions between the cooperating forklifts.

#### 3.2. Scenario 2

In order to compare the resulting times, it was assumed that the second scenario would be similar to the previous one. Forklifts operating inside the facility were assumed to transport products directly to a safe location. The stopping time is 10 seconds to remove the pallet from the rack and to put the pallet back at the destination (Figure 9).





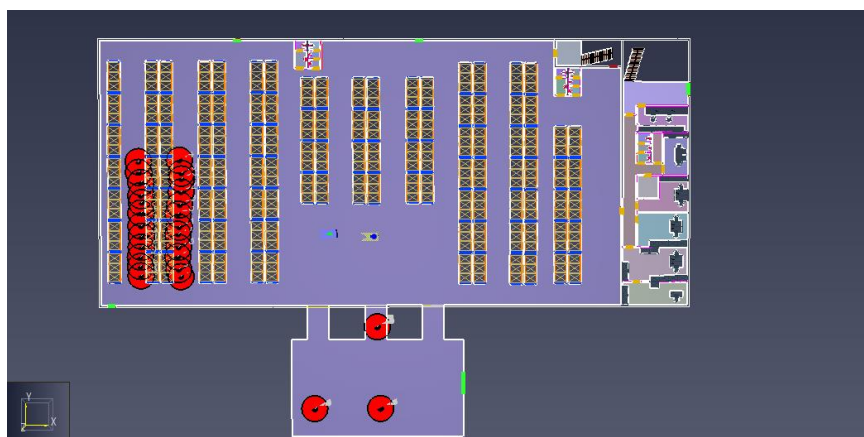
**Figure 9.** Evacuation of products - Scenario 2. Red circles mark points of movement of forklifts.

Source: Sopoćko, 2019.

The resulting evacuation time using the assumptions of this scenario was 1044.3 seconds. As in the previous scenario, there were no collisions between operating forklifts.

### 3.3. Scenario 3

The warehouse contains a variety of assortments, but the highest-value portion is stored on the racks furthest from the entry gates. It was assumed that two forklifts evacuate part of this rack through two sectional gates. As in the previous variant, the forklifts retrieve the pallets with the assortment and transport them to the required location. A standstill time of 10 seconds was assumed for both loading and unloading (Figure 10).



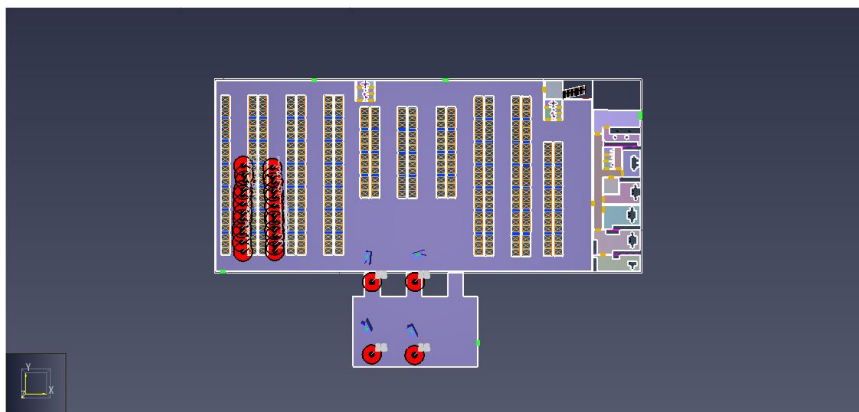
**Figure 10.** Evacuation of products - Scenario 3. Red circles mark points of movement of forklifts.

Source: Sopoćko, 2019.

The evacuation time obtained using the assumptions of this Scenario was 665 seconds. During the simulation, the forklifts passed each other without causing a stop or prolonging the evacuation process. The equipment operated at its own pace, which was assumed beforehand.

### 3.4. Scenario 4

In order to compare the results, Scenario 4 involved the evacuation of products distributed in the same area as in Scenario 3. It was assumed that Group C products would be evacuated. Two forklifts were assumed to operate inside and two outside the warehouse. As in the previous scenario, the forklifts operating inside the warehouse retrieve the assortment and then transport it just outside the sectional gate, with a stopping time of 10 seconds to remove the pallet from the rack and 5 seconds to put the pallet back just outside the gate. In contrast, forklifts outside the warehouse retrieve pallets and transport them to their destination. A standstill time for them was assumed equal to 5 seconds to put the pallet on the forks and 10 seconds to remove it (Figure 11).



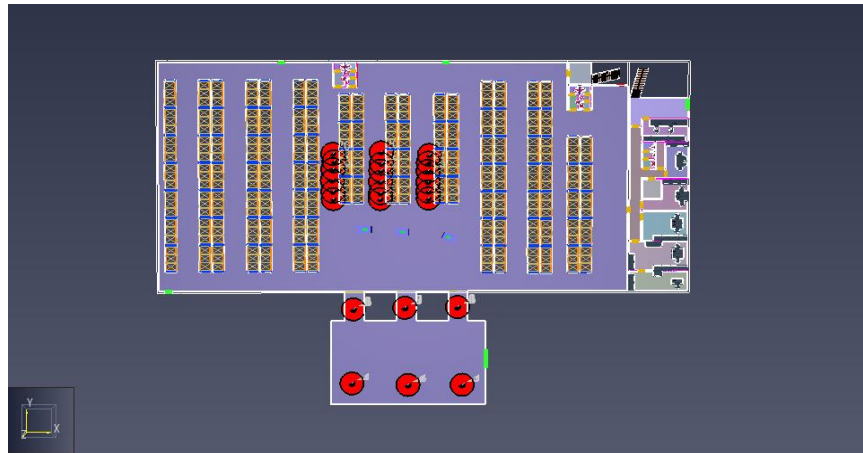
**Figure 11.** Evacuation of products - Scenario 4. Red circles mark points of movement of forklifts.

Source: Sopoćko, 2019.

An evacuation time of 560.4 seconds was obtained during the simulation. As in the previous Scenario, there were no collisions. The devices performed their work according to the imposed "behavior".

### 3.5. Scenario 5

This variant assumes that it is necessary to evacuate from the warehouse products near the sectional gates, or more precisely the assortment of group A, I, J, H, F and B. Three forklifts will be used for the evacuation, which will transport the assortment to the outside. The scenario dictates in advance an evacuation time of 2 minutes, as beyond this time visibility and safe conditions of evacuation will decrease (Figure 12).

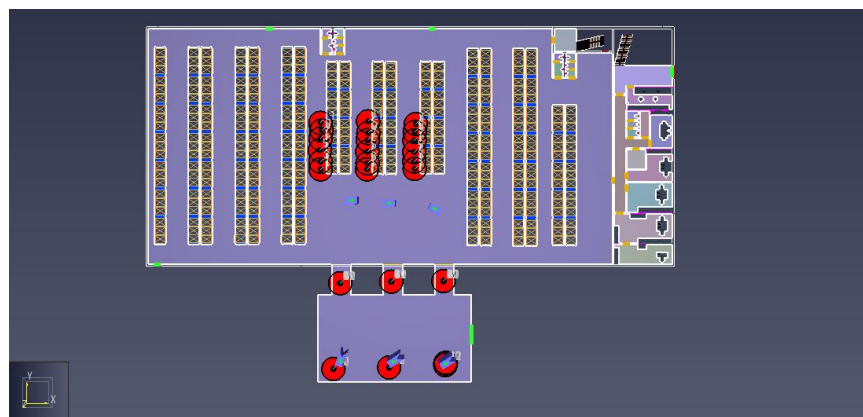


**Figure 12.** Evacuation of products - Scenario 5. Red circles mark points of movement of forklifts.

Source: Sopoćko, 2019.

### 3.6. Scenario 6

In order to compare the resulting evacuation times and choose the optimal solution, it was assumed that Scenario No. 6, would be similar to Scenario No. 5. It was assumed that the goods of groups A, I, J, H, F and B would also be evacuated, and the evacuation time would be 2 minutes. The change that has been made mainly concerns the operation of forklifts. It has been planned that 3 forklifts will work both inside and outside. The equipment working inside picks up the goods and then transports them just outside the sectional gate. The stopping time is 10 seconds to remove a pallet from the rack and 5 seconds to put it back in a given place. The forklifts working outside already transport them to their destination, and their standstill time was 10 seconds (Figure 13).



**Figure 13.** Evacuation of products - Scenario 6. Red circles mark points of movement of forklifts.

Source: Sopoćko, 2019.



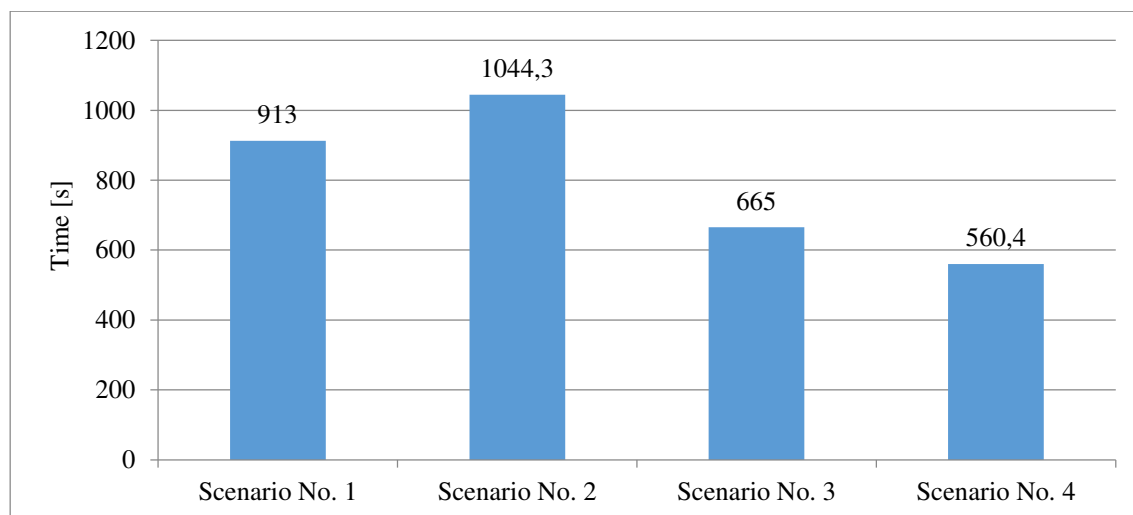
In the previous incident scenarios, the goal was to determine the evacuation time of the goods. In Scenarios #5 and #6, a fixed evacuation time was assumed (2 minutes), hence it was investigated what amount of assortment could be transported out of the warehouse. Table 3 presents a diagram of top views of the evacuated warehouse in two variants (Scenarios #5 and #6). With the help of red frames, the racks from which it was possible to evacuate the stored products within 120 seconds were marked. Based on the results obtained, it can be seen that with Scenario No. 5, forklifts operating inside the warehouse performed 3 full work cycles (that is, they retrieved the goods and placed them in a safe place), while with Scenario No. 6 - 5 cycles. The obtained results can provide a basis for introducing measures to improve the property evacuation process in the future.

**Table 3.**

*Comparison of the quantity of the evacuated product range*



Source: Sopoćko, 2019.



**Figure 14.** Evacuation of products - obtained times.

Source: Sopoćko, 2019.

The above graph (Figure 14) shows the times that were obtained during the simulation of property evacuation. In the case of the implementation of evacuation according to the variants where the forklifts worked in parallel inside and outside the warehouse, shorter evacuation times are obtained - this is confirmed by the simulation for Scenarios No. 1 and 4. In the situation where the forklifts working inside the warehouse were to directly evacuate the property outside, the evacuation time increased - as shown by the simulation for Scenarios No. 2 and 3. In the case of simulation No. 2, the evacuation time was 131.3 seconds greater, as in the case of simulation No. 3 - the obtained time increased by 104.6 seconds.

## 4. Discussion

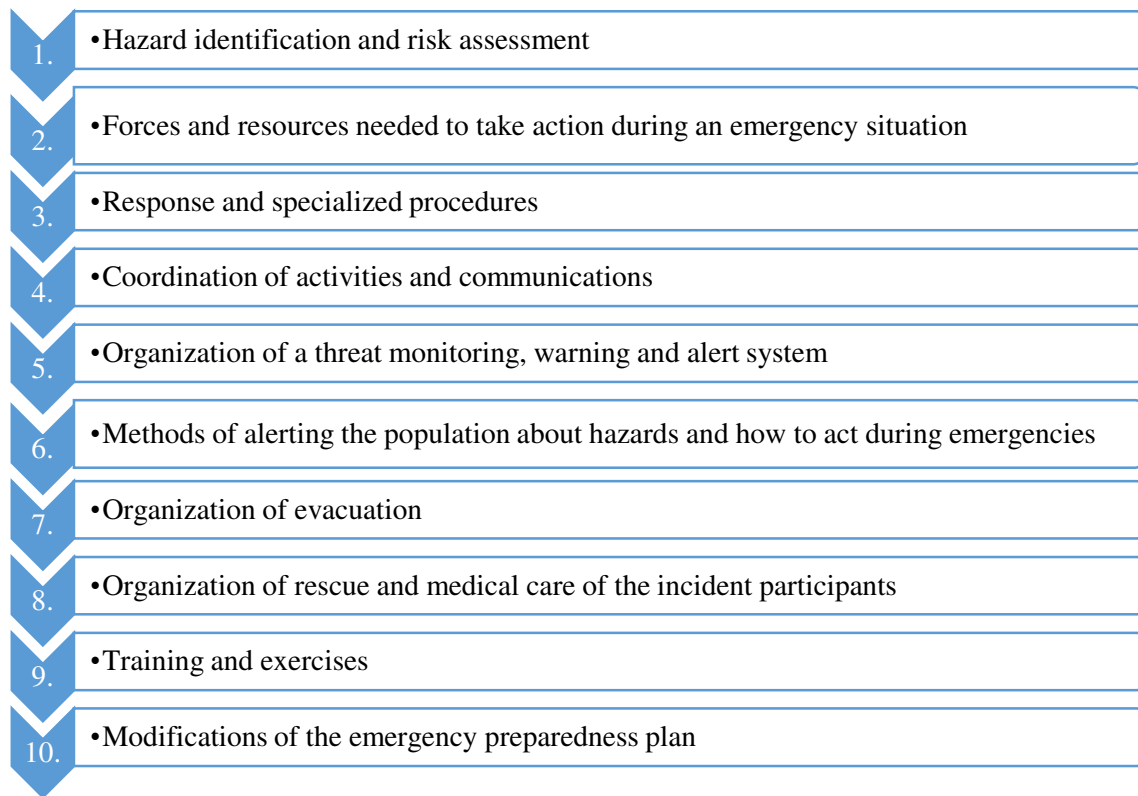
Preparing for evacuation should be preceded by, among other things, organizing systems (Dahlke, Idczak, 2021):

- threat detection (internal (in-company) and external (off-site)),
- notification of hazards (or their level) requiring evacuation,
- analysis of the effectiveness of evacuation operations (preparation of effectiveness measures),
- design and implement changes to improve evacuation efficiency,
- evaluation of implemented improvement changes.

The last three activities mentioned above can be analyzed using simulation models that replicate actual evacuation conditions. These activities are intended to prevent losses and can be a supporting element (Mannan 2012):

- threat identification techniques,
- quantitative approach to threats,
- quantitative assessment of risks and their evaluation against risk criteria,
- reliability engineering techniques,
- principles of independence in critical evaluations and inspections,
- planning for emergencies,
- incident investigations along with a critical look at traditional practices or existing regulations, standards and codes if they seem outdated due to technological changes.

The results of the simulation modeling presented in Chapter 3, can be part of the aforementioned emergency response plan. An example of the structure of such a plan is presented in Figure 15.

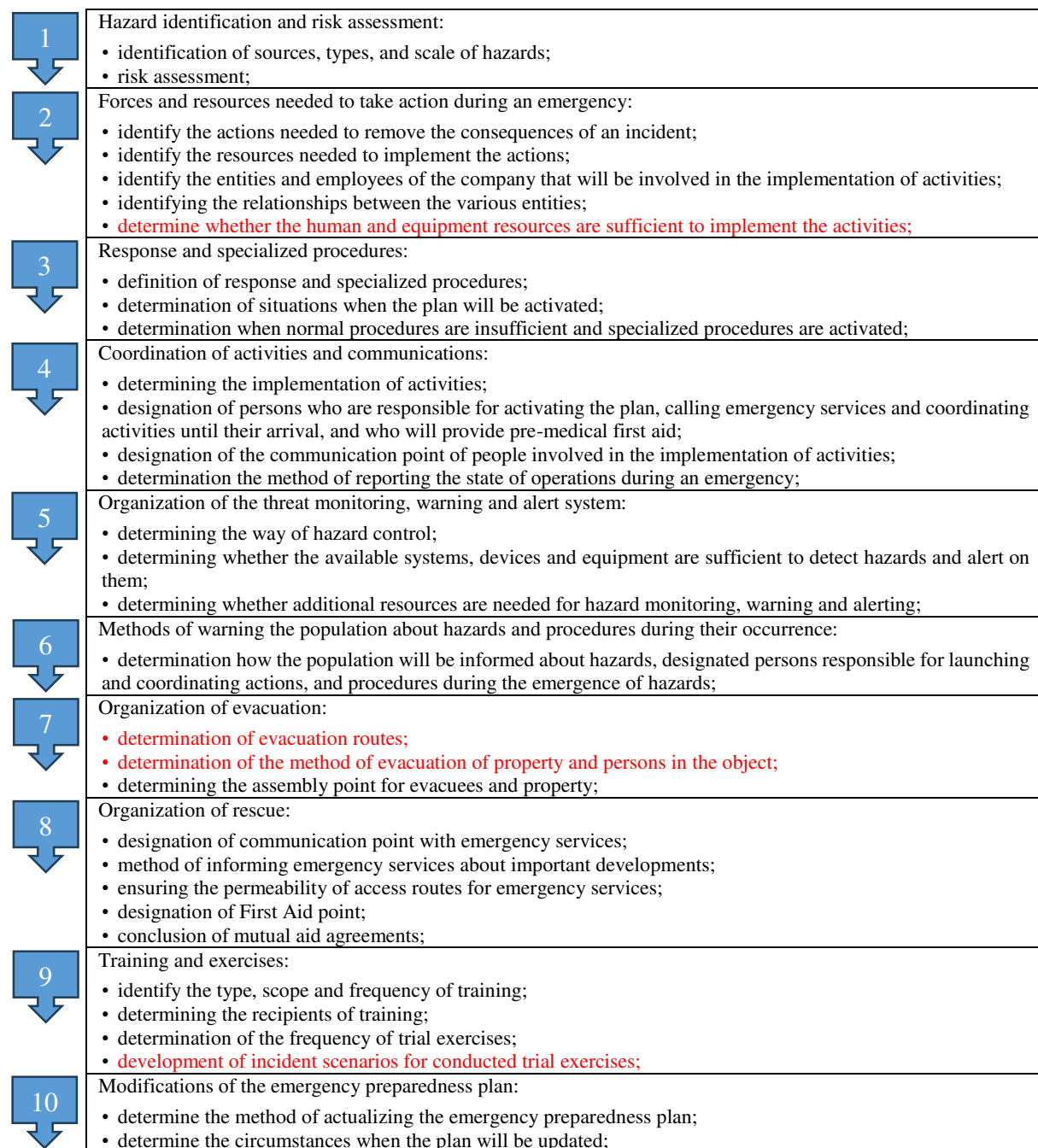


**Figure 15.** List of the main components of the emergency preparedness plan.

Source: Sopoćko, 2019 based on the Association of European Railways, 2001, pp. 1-67, and Dz.U. of 2007. No. 89, item 590.

The development of an emergency preparedness plan is a kind of strategy involving prevention and minimization of possible consequences. Undoubtedly, in order to facilitate the process of preparing such a document, you can use the evacuation simulation carried out earlier. Figure 16 shows what undertakings and annexes are required and should be included in such a plan. The red color indicates those functions that can be supported by evacuation simulation modeling. These include:

- identify appropriate human and equipment resources,
- designation of evacuation routes,
- determine the method of property evacuation, and also
- development of scenarios for trial evacuation.



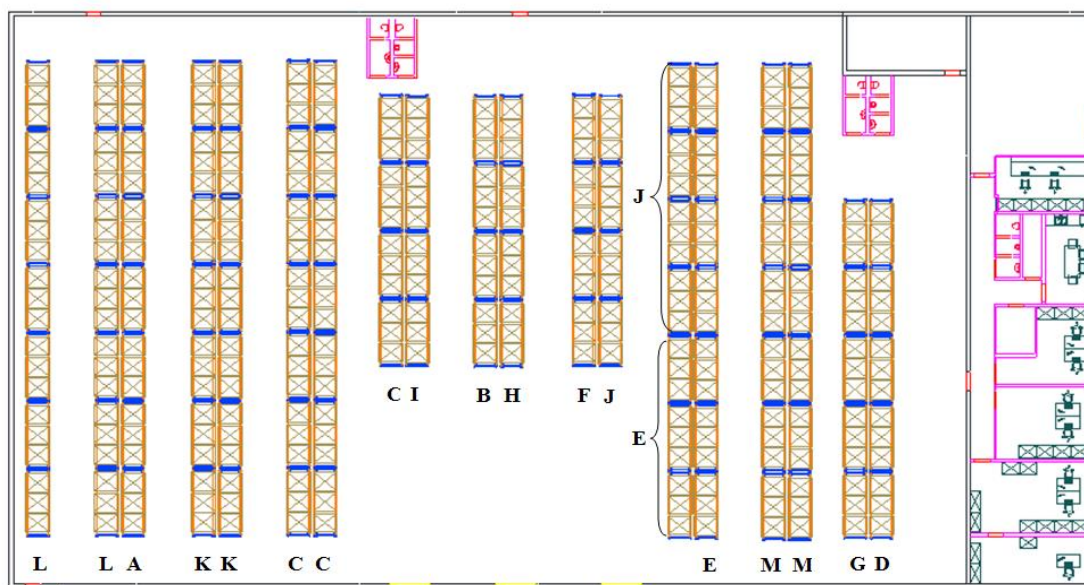
**Figure 16.** Activities and annexes of the emergency preparedness plan.

Source: Sopoćko, 2019 based on the Association of European Railways, 2001, pp. 1-67, and Dz.U. of 2007. No. 89, item 590.

Performing an evacuation simulation can also enable to propose the investigated enterprise, first of all, organizational and technical changes that can contribute to the shortest possible evacuation times during an emergency incident.

Unfortunately, the investigated enterprise does not have a developed emergency preparedness plan. It is therefore necessary to designate a team of people who will be responsible for developing and periodically updating this document. The content of the draft document should include, for example, the method of alerting about identified hazards, especially of threats requiring the evacuation of people and property. In addition to the issue of

evacuation of the people, the information relating to the evacuation of property from the warehouse should be included. In the research part, a simulation was performed based on the actual distribution of the assortment in the warehouse. By performing an assessment of the value of the assortment, we determined that the valuable products are located quite far from the gates through which property can be evacuated. Based on the results, some changes in the layout of products were suggested (Figure 17). It was recommended that the evacuation of property be carried out by forklifts operating inside and outside the warehouse. The obtained results clearly showed that this variant of operation is more favorable, since shorter evacuation times are obtained in each case considered. Performing simulation of evacuation may enable the company to receive an answer to the question about the sufficiency of available resources of equipment to implement such a process in the situation of a sudden and unexpected incident.



**Figure 17.** Proposal of assortment distribution correction.

Source: Sopoćko, 2019.

The team who is responsible for preparing and updating the emergency preparedness plan should determine the rules for conducting training and practical evacuation exercises. Conducting a trial evacuation is a requirement of the law, and its purpose is a practical verification of knowledge and, at the same time, raising awareness among facility users about the possible dangers and hazards that may occur. In addition, during this type of exercise, people acquire the skills to act (Chudy, 2016, p. 42). It is worthwhile to conduct a trial evacuation on the basis of a previously prepared scenario which is likely to occur. Before conducting such an exercise, the evacuation can be simulated in Pathfinder software to eliminate errors that may occur during the exercise, but it also allows to visualize how the exercise will be conducted. Performing an exercise allows to receive information about a plan's correct and assumed functionality, and what should be improved in the plan.

The last aspect to which attention should be given is training, which should be organized not only for newly hired employees, but also for those already employed. Each person should be trained in first aid and fire safety features present in the facility, but also in the contents of the emergency preparedness plan. In addition, every employee should be introduced to any changes in the plan by receiving update training.

## 5. Summary

The applicative conclusions presented in Chapter 4, provide an example of the implementation of simulation modeling in enterprise security management. This example can be viewed as a universal approach to decision support for planning of response to incidents requiring evacuation of products from the warehouse. In the research section, among a number of evacuation support tools, Pathfinder software was used to run a simulation for an example organizational unit. Before conducting the simulation, various types of evacuation scenarios were prepared. One of the most important steps in collecting data for the development of evacuation scenarios is the identification of hazards whose impact may, depending on the acceptable level, require evacuation. Both the scenarios and their mapping during simulation modeling require quantitative data (Drzewiecka-Dahlke, 2017), which can also be analyzed during trial evacuations, becoming measures of the effectiveness of evacuation conditions.

An emergency situation is an unplanned and sudden incident that cannot be predicted, but by implementing appropriate procedures it is possible to minimize its effects. During the occurrence of such a situation, it is important to ensure safe and efficient evacuation. Achieving this is possible by conducting systematic and periodic rehearsal exercises, through which the users of the facility will increase their awareness of the risks, but also as a result will be influenced on the final evacuation time.

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## MULTI-CRITERIA DECISION ANALYSIS IN QUANTITATIVE RESEARCH

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**Purpose:** Paper provides an overview of the methodology and diverse applications of Multi-Criteria Decision Analysis MCDA. Also shows criteria and analytical activities in the process of quantitative scientific research. An approach to selecting the company's operating strategy and its strategic position in relation to the environment in which it operates is presented. A model approach to consumer behavior was assessed.

**Design/methodology/approach:** It provides insights into weighting criteria, aggregating preferences, and sensitivity analysis. During the analysis of criteria and analytical activities, a broad literature review was used, comparing the most popular and most effective methods of operation.

**Findings:** Verification problems of multi-criteria selection problems are the problem of practical identification of which elements of actual market behavior are equivalent to theoretical categories. It is also necessary to verify the regularities occurring in these behaviors by confronting them with the actual behavior of consumers and determining compliance with the regularities occurring in this course.

**Practical implications:** Decision analysis can be used directly in solving problems with various decision-making contexts and in analytical work related to organizing objects or building a multi-criteria ranking. As MCDA continues to evolve in the quantitative research landscape, it remains central to facilitating informed decisions, accommodating trade-offs between criteria, and strengthening the rigour of quantitative analysis.

**Originality/value:** The article defines the most important methods of consumer behavior and activities in enterprises, which behaviors and activities are conditioned by the external environment and market rules; highlights applications of MCDA in real-world problem solving.

**Keywords:** quantitative scientific research, multi-criteria analysis, consumer behavior, decision analysis, MCDA.

**Category of the paper:** literature analysis.

**Keywords:** decision analysis, quantitative research, analytical activities.

## 1. Introduction

According to T. Wachowicz (2016) a useful group of formal tools proposed by operations research, within the framework of multi-criteria problems, are methods of multi-criteria decision analysis (MCDA).

According to (Figuera et al., 2005; Aguinis et al., 2019; Aubert et al., 2023; Dyer, Nobeoka, 2000; Kogetsidis, 2023; Kharazishvili et al., 2020; Dźwigoł et al., 2021, 2023a, 2023b; Kwilinski, 2023; Kwilinski et al., 2020, 2022a, 2022b, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g; Moskalenko et al., 2023; Islam, Widen, 2023) MCDA focuses on decision-making problems in which the multiplicity of objectives makes it difficult for the decision-maker to decide on a particular solution - a decision option - on the basis of intuition. The burden of these problems is so heavy that there is no room for inefficient or erroneous decisions, which are the inevitable result of simplistic thinking patterns or quick heuristics (Gigerenzer, Todd, 1999). For this reason, the MCDA develops a number of analytical tools to help the decision-maker to define the decision problem accurately, determine its structure, organise information about the decisionmaker's own preferences, and build a system for evaluating decision options based on this information (Wachowicz, 2016, p. 403; Beach, Pedersen, 2016).

High-criteria methods can be used to analyse data that come from descriptive surveys and to generate multi-criteria rankings, sorting or classifying objects into predefined categories (Yin, 1984; Wachowicz, 2016, p. 403; Yin et al., 2024; Yang, Chen, 2023).

All multi-criteria decision-making problems are characterised by a certain fixed set of characteristics that make it possible to create a synthetic description of the phenomenon under study. These include (Wachowicz, 2016, p. 404):

- at least one decision-maker who is faced with a decision-making problem under investigation,
- a finite or infinite set of decision options that describe possible ways of solving a decision problem (the description or evaluation is of interest to the decisionmaker),
- the decision-maker's preferences, which constitute a system of externally and internally determined priorities in relation to the various possible levels of implementation of individual issues.

It is also necessary to define the analytical objective of the decision-maker's action, which allows the type of problem to be defined and then potential methods to analyse it to be identified.

In order to obtain a valid and reliable assessment of a company's strategic position, it is necessary to choose the right research method. One such method is the SPACE (Strategic Position and Action Evaluation) (Becker et al., 2021; Dul, Hak, 2008; Dźwigoł, 2001, 2003, 2009, 2018, 2019a, 2019b, 2020, 2021a, 2021b, 2022a, 2022b, 2023; Dźwigoł, Wolniak, 2018;

Dźwigoł et al., 2019a, 2019b, 2019c, 2020a, 2020b; Dźwigoł, Trzeciak, 2023; Dźwigoł-Barosz, Dźwigoł, 2021).

Issues relating to consumer behaviour in the marketplace are becoming increasingly important in the global economy, which is linked to the strong increase in market competition and the rapidly changing patterns of consumer behaviour and decision-making (Smyczek, 2016; Ares, Varela, 2018; Trushkina et al., 2020; Rezaei, 2016; Meißner, Oll, 2019).

This paper presents the criteria and analytical activities in the quantitative research process. Through the use of the SPACE method, it presents an approach to the selection of a company's operating strategy and its strategic position in relation to the environment in which it operates.

It evaluates the model-based view of consumer behaviour, which entails many limitations and many advantages.

## 2. Multi-criteria problems and analytical activities

Decision theory presents a simple classification of multi-criteria problems taking into account the criterion of the type of analytical problem, i.e. (Roy, 1996):

- descriptive problems - the decision-maker is not interested in finding a specific solution to the problem that is in line with his or her preferences (acceptable, sufficient, quasi-optimal or optimal) or that meets quantified requirements,
- selection problems - the decision-maker's actions are directed towards analysing a set of decision options and selecting from among them those which, in the light of the adopted evaluation criteria and subjectively identified preferences, will prove to be good enough - satisfactory,
- sorting (classification) problems - the decision-maker's objective becomes to assign the options to categories or similarity classes previously identified,
- ranking construction problems - the decision-maker aims to build a complete or partial order on the set of options analysed.

According to T. Wachowicz (2016) an analysis of the literature makes it possible to conclude that more and more often a specific algorithm of analytical action is assigned to a particular multi-criteria method, which takes into account the technical nuances of the method. At a certain level of generality, however, a universal procedure pattern is proposed. A proposal for such a procedure is the PrOACT algorithm (Hammond, 2002) (Problem, Objectives, Alternatives, Consequences, trade-offs), which synthetically describes the tasks aimed at structuring, describing and solving a multi-criteria decision problem.

The analytical action procedure within the PrOACT algorithm consists of the following of the following steps (Wachowicz, 2016, pp. 408-413; Barnes, 1984; Gilovich et al., 2002, p. 513; Keeney, Raiffa, 1976, p. 367):

- formulation of the decision problem - an important element of decision analysis is the correct definition of the problem faced by the decision-maker (creativity, a certain systematicity of action is important). The starting point is formed by the identification of a first, intuitive definition, followed by a thorough presentation of this definition. Once the decision-maker has formulated the problem individually, he or she should also consult other people: colleagues, experts, acquaintances, potential stakeholders in the case, as well as those who are substantively uninterested in the problem - this will allow gaining a new perspective on the issue under analysis;
- defining the assessment objectives/criteria - it is very important to define them properly, as they directly determine the criteria that the decision-maker will use when assessing potential solutions to the formulated problem and during the search for different solution options itself. In addition, they indicate what information the decision-maker should seek about the options in order to be able to carry out a reliable and credible analysis;
- search for decision options - these represent alternative solutions to the decision problem under consideration by the decision-maker. Their identification is not a difficult process, however, it requires time and focus. The most common mistakes in identifying decision options are those that result from schematic thinking and the application of various heuristics, e.g. availability heuristics;
- identification of the consequences of the options in the light of the adopted evaluation criteria - in order to make a decision on the most advantageous solution to the problem, it is necessary to know how the identified decision options satisfy the objectives adopted by the decision-maker. The decision-maker's task is to specify precisely, by means of the form of description adopted, the consequences of accepting each option for each of the assessment criteria. The formal point of this step is the consequences table;
- carry out a compensation/preference analysis - if the decision-maker has defined the problem in terms of a selection, sorting or ranking task, he/she must make a comparison of the options specified in the consequences table. Such a comparison is not straightforward, as the defined objectives are generally conflicting in nature. The task of the multi-criteria comparison is to answer the question of how the poor performance of the options for some of the criteria can be compensated for by exceptionally good levels of achievement of the other objectives, and how, in such an overall compensation, the option compares with the others. Such a comparison is carried out on the basis of the individual, subjectively defined preferences of the decision-maker and is called a compensation analysis, or in general terms a *trade off* analysis.

From the point of view of the decision-maker's choice of a particular method, their two typologies seem to be the most relevant, which relate to the way in which preference information is processed and the generation of the results of the compensation analysis (Wachowicz, 2016, p. 413). The first typology relates to the distinction between methods based on a synthetic criterion (they aim to determine a scalar evaluation of multi-criteria options,

using a scoring system or individual evaluation, utility or value functions) and synthetic superiority methods (they refer to a relational system of preferences, in which the existence of superiority relations or the degree of this superiority is examined for the variants being compared with each other) (Wachowicz, 2016, p. 414).

The second division relates to techniques for conducting the decision-maker's preference analysis process. Three groups of methods can be distinguished here (Wachowicz, 2016, p. 415):

- pair-wise comparison methods (the decision-maker describes his/her preferences by comparing them for each criterion separately with the results proposed by the other solutions identified in the consequences table),
- direct assessment methods (which involve analysing the levels of achievement of each criterion separately and in isolation from the options that both create and generate a rating scale for that criterion. The single-criteria scores are aggregated to a scalar synthetic score),
- holistic methods (it is more convenient for the decision-maker to make a determination of his or her preference for certain sample decision options, not necessarily those that form an array of consequences).

As stated by D. Górecka (2011) there is no unambiguous algorithm for recommending a specific compensation analysis method for solving a specific decision problem with a specific type of problem and structure.

According to W. Edwards and F.H. Barron (1994), the SMART method is the simplest and most popular technique for conducting compensation analysis. In general terms, the SMART algorithm copies the SAI sum-of-importance method, however, it allows the decision-maker to freely shape the evaluations of the consequences of the decision options without imposing the need to model the decision-maker's preferences using linear evaluation functions (Churchman, Ackoff, 1954). The concept of hybridising the two concepts, i.e. SMART and SAI, is known in the literature as SMARTER. However, it absolutely assumes the use of the idea of SAI when generating evaluations of each decision criterion (Edwards, Barron, 1994).

The compensation analysis algorithm according to the SMART procedure, supplemented by solutions derived from the SAI approach, consists of the following steps (Wachowicz, 2016):

- Step 1. Determining the relevance of the evaluation criteria - the SMART method expects the decision maker to determine the relevance of the evaluation criteria (objectives) taking into account the weights (the weights must add up to some specific value, which is the rating point pool of the evaluation system being created - this is required by the algorithm). This pool is assumed to range from 1 or 100. This requirement is written as:  $\sum_{j=1}^m w_j = 1$ , where:  $w_j$  - the weight (relevance) of the  $j$ -th rating criterion;  $j = 1, \dots, m$  is the number of the rating criterion (e.g. derived from the order of occurrence in the consequence table).

It should be noted that with this allocation principle the weights have a quotient interpretation. If the decision-maker finds the decisive allocation of weights difficult or unintuitive then he or she can use selected methods or supporting procedures, e.g. (Saaty, Vargas, 2012; Goodwin, Wright, 2011): the AHP method, the algorithm for generating spanning weights or selected verbal scales.

- Step 2. Determine the consequence score of each option for the decision criterion separately - the decision-maker's task is to assign each level of implementation of each criterion a score from the range of  $\langle 0; 100 \rangle$  (the most favourable level of implementation of a given criterion receives a score of 100 and the least favourable one receives a score of 0 - the resulting scale is a range scale).

Thus, to each level of realisation, i.e. the consequence of the  $i$ -th option for the  $j$ -th decision criterion  $x_{ij}$ , the decision-maker assigns a rating  $v(x_{ij})$ , i.e.:  $x_{ij} \rightarrow v(x_{ij}) \in \langle 0; 100 \rangle$ .

- Step 3. Calculation of the global rating of each option - is determined by an additive aggregation of single-criteria  $v(x_{ij})$  ratings weighted by the importance  $w_j$  of objectives:

$$V_i = \sum_{j=1}^m w_j \times v(x_{ij})$$

for each  $i = 1, \dots, n$ , where  $n$  is the number of decision options in the consequence table. The evaluation system retains the properties of an range scale. It allows complete rankings of decision options to be made from a table of consequences and compared with each other. The most favourable option receives a score of 100 and the least favourable (with the worst consequences) is given a score of 0.

### 3. SPACE method

The most important decisions that companies take and that affect their development concern the strategic aspects of their business. The strategic decisions taken by enterprises should therefore be carefully analysed. The starting point for choosing a company's operating strategy is to assess its strategic position in relation to the environment in which it operates.

The SPACE method is one of the methods that makes it possible to analyse a company's development capacity, strategic positioning and evaluation of its activities (Krupski, 2009).

This method is based on the aggregation and balancing of internal and external dimensions determining the state of the company and its environment. The combination of these two dimensions enables the company to determine the "P" point, which defines the company's position, which is the starting point for the selection of strategic options (Stabryła, 2000).



The assessment of a company's strategic position and viability is done using a matrix consisting of two main dimensions:

- external,
- internal.

The external and internal dimensions of the matrix are described in terms of the aspects shown in the following table (Lisiński, 2004).

**Table 1.**

*Dimensions of the SPACE matrix*

<b>Internal dimension</b>	<b>External dimension</b>
Financial strength of the company	Strength of the sector (industry) in which the company operates
Competitive advantage of the company	Stability of the company's environment

Source: compiled on the basis of (Lisinski, 2004, p. 253).

The aspects of the analysis of the company and its environment presented in the table can be assessed and characterised by a variety of variables. These variables include (Moszkowicz, 2005):

- From the point of view of a company's financial strength, evaluation variables include liquidity, working capital, cash flow and decision risk, among others.
- From the point of view of a company's competitive advantage, evaluation variables include: market share, product life cycle, product quality, accessibility to distribution networks, customer loyalty, indigenous skills, environmental performance of technology, among others.
- From the point of view of the stability of a company's environment, evaluation variables include, among others: inflation rate, unemployment rate, intensity of competition, barriers to entry, stability of prices for final products and supply goods, volatility of demand.
- From the point of view of the strength of the sector (industry), evaluation variables include: growth potential, industry profitability, financial stability, among others.

Other variables assessing and characterising the dimensions of the SPACE matrix can also be found in the literature. These variables are presented in the following table (Drażek, Niemczynowicz, 2003).

**Table 2.**

*Examples of variables characterising the dimensions of the SPACE matrix*

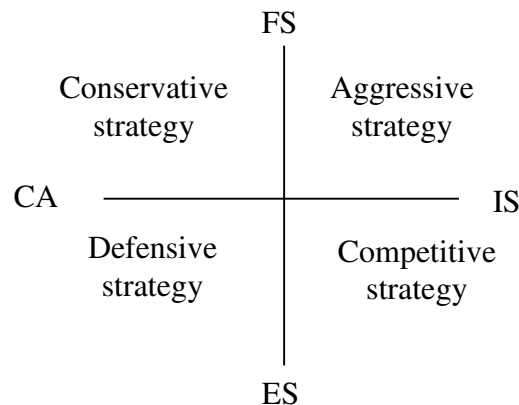
<b>Financial strength of the company</b>	<b>Industry stability</b>
- profit rate indicator	- stage of development of the company
- production cost	- sectoral innovation
- return on capital	- the sector's dependence on the economic climate
- profit stability	- longevity of the sector
- return on investment	- inflation in the industry
- liquidity	- profit stability
- debt	- inflow of foreign capital into the sector
- ability to increase accumulation and acquisition	- competition in the sector

Cont. table 2.

Competitive ability of the company	Strength or attractiveness of the sector (industry)
- the market and its coverage	- characteristics of competition
- the company's market share in dynamic terms	- industry life cycle phase
- assortment structure of production	- dependence of the development of the industry or sector on the economic situation
- marketing skills	- social attractiveness of the sector
- the ability to actively influence price and cost levels	- the lifespan of an industry or sector
- customer relations	- structure of applications of the choice of industry in other sectors of activity
- profitability of sales	- profit stability

Source: compiled on the basis of (Drażek, Niemczynowicz, 2003, p. 186).

In applying the SPACE method and determining a company's strategy, it is necessary to present four assessment areas (financial strength - FS, competitive advantage - CA, industry stability - ES, industry strength - IS on a coordinate system). The coordinate system is shown in Figure 1 (Rowe et al., 1982).



**Figure 1.** Coordinate system of the SPACE method.

Source: compiled from (Rowe et al., 1982, p. 756).

The ordinate (y+) axis denote the financial strength of the company, on the (y-) side the stability of the industry is presented. On the abscissa axis, on the other hand, (x+) denotes the strength of the sector, the (x-) side competitive advantage. Each quadrant of the system is furthermore associated with the choice of a different operating strategy and is characterised by different features:

- aggressive strategy - the company has a good financial position in a given environment and a high position in an industry with medium attractiveness.
- conservative strategy - the company has a good financial position in a given environment, but a low competitive position in an industry with at most average attractiveness, or it operates in an unattractive industry and has at most an average competitive position.
- defensive strategy - the company has a weak financial position in the environment in which it operates and at the same time has a low competitive position in a moderately attractive industry, or operates in an unattractive industry and has a medium competitive position.

- competitive strategy - the company has a weak financial position in the environment in which it operates, but has at least an average competitive position in a moderately attractive industry, or operates in a moderately attractive industry but has a high competitive position.

#### **4. Models of consumer behaviour in the market**

Economic phenomena, including aspects related to consumer behaviour, are complex and difficult objects to model. This is because, when analysing consumer behaviour, it is necessary to take into account the rapid changes occurring in the environment in which these changes take place. Furthermore, when analysing consumer behaviour, it is necessary to consider it at a higher level (not only in terms of the consumer's reaction), but also to take into account the whole sequence of behaviour, i.e. the activities preceding the purchase, the purchase itself and the activities following it (Smyczek, 2016).

A model is a representation of reality in a simplified way that shows, at the same time, the relationships that exist between the different elements of a given system, after having first analysed it (Schiffman et al., 2018). Applying this definition to issues related to consumer behaviour, it can be postulated that models of consumer behaviour are a simplified representation of actual behaviour, which is intended to show the relationships between the various elements of a process or system after an analysis of the problem. They refer to a systematic selection of features that represent the interrelationships and theoretically capture the coming to fruition of a specific action (Swiatowy, 2006, p. 41).

Models of consumer behaviour are often equated with patterns of behaviour. However, this is not correct, as consumer behaviour patterns are a holistic reflection of current regularities and patterns of consumer behaviour (Nowak, 1970; Peffers et al., 2007; Raich, 2009). Patterns of consumer behaviour are not uniform and fixed (Solomon et al., 2010; Meißner, Oll, 2019; Patil, 2016; Rajesh, 2023), they are applied to currently observed consumer behaviour and mean socially recognised and respected patterns and realised patterns, i.e. functioning and real (Smyczek, 2016; Hryhorak et al., 2021; Sieklicki, Tanev, 2021; Silverman, 2008).

A model of consumer behaviour, on the other hand, is a simplified diagram representing consumers' actual behaviour (Evans et al., 2009; Gephart, 2004; Graebner et al., 2012).

The aim of behaviour modelling should be to reproduce as faithfully as possible the structural features of the behaviour in question, if not in terms of the elements themselves, then at least in terms of their characteristics. In addition, any model should be based on the many constraints and assumptions made (Smyczek, 2016; Tight, 2017; Tandukar, 2018; Wątróbski et al., 2019; Xiang, Hou, 2023).

A model-based approach to consumer behaviour has many limitations, but there are also many advantages and areas of application of such models, e.g.: they help to develop theories, understand complex consumer-market relations and relationships, or explain consumer decision-making processes. They therefore have functions (Krzyżanowski, 1999, p. 87): explanatory, predictive, descriptive-analytical and utilitarian.

Taking into account the broadest criterion for the division of consumer behaviour models, i.e. the degree of their complexity, one can list: 1) simple models, which present and explain consumer behaviour in a general way, present only the main factors influencing their behaviour (Hawkins, Best, 2004), are simple and easy to apply, but are often of negligible use in the marketing activity of a company, 2) complex models, which more fully explain consumer behaviour in the market and focus on the decision-making process of the individual. The group of simple models can include: black box models, which do not include research into the internal decision-making processes of consumers, but are the result of direct reactions affecting the consumer and the reactions they elicit, decision-making process models, which represent the various stages of consumer decision-making and are very widely used in the marketing activities of companies, personal variable models, which focus on the internal factors shaping consumer behaviour and attempt to explain individual internal decision-making processes, and hybrid models, which attempt to combine the features of a decision-making model and a personal variable model. Consumer behaviour in the market is most fully reflected by decision process and hybrid models. Among the complex models of consumer behaviour, in turn, three types of models can be distinguished: structural models, which depict the key features and their interrelationships, through which the mental processes explaining how consumer behaviour comes to an effect are shown, e.g. the Howard-Sheth model, Nicossi model, Engel-Kollat-Blackwell (EKB) model, stochastic models, which attempt to predict by probability calculus the behaviour of consumers in a market, but do not reflect factors that are inside, e.g. Markov model, simulation models, which attempt to explain consumer behaviour by means of special simulation techniques under varying circumstances assuming specific entry points, e.g. Triandis model. Among the highest rated complex models of consumer behaviour are the Nicosia model, highlighting the relationship between consumers and companies, and the EKB model, which best demonstrates various aspects of customer behaviour in the market (Smyczek, 2016).

In addition to these models, it is also worth noting:

- The Sheth's model of family decision-making, which explains the processes within the family and their impact on purchasing decisions (Harris, 2010, p. 147).
- The Sheth-Newman-Gross model of consumption value, which explains the reasons for consumers' choices in the market and focuses attention on estimating the value of consumption (Sheth et al., 1991).
- The Dirichlet model, a stochastic model of buyer behaviour at the individual consumer level in markets that are unsegmented and stable (Ehrenberg, 1991).

- Markov model of consumer behaviour, i.e. a stochastic model that specifies that consumer behaviour in the market is a continuous decision-making process in which specific states are exchanged in successive units of time and in which the achievement of some state in a specific period  $t$  is conditional on the achievement of some state in the previous period  $t - 1$  (Rudnicki, 1996).
- The Triandis model of consumer behaviour, a simulation model that is used when a system of structural and stochastic models cannot be solved mathematically and analytically (Smyczek, 2016, p. 341),
- The Bettman model, which depicts decision-making as information processing that follows a consumer-controlled, consciously defined programme (Bettman, 1979, p. 278).

Taking into account the models presented above, it is possible to conclude that many types of models, both simple and complex, can be used to show the behaviour of consumers in the marketplace (Smyczek, 2016) in detail.

A properly constructed model of consumer behaviour should (Phipps, Simmons, 2009, p. 215):

- be based on facts,
- explain how and why certain market behaviours occur,
- be characterised by simplicity - presenting different aspects of consumer behaviour in a clear and easily understandable way,
- be original - develop knowledge,
- identify new areas of research into consumer behaviour,
- be subject to verification,
- help predict how consumers will react to certain factors in the market,
- be logical - the model should be plausible and the phenomena it presents should be internally consistent and make sense.

It is difficult to meet the above criteria simultaneously, but they are worth considering as a useful framework for building and estimating the relevance of individual models (Smyczek, 2016, p. 242).

The procedure for constructing models of consumer behaviour in the market is a five- stage process:

- defining the purpose of building the model, within which it is necessary to identify the research problem and to formulate the research hypotheses (Smyczek, 2016, p. 243);
- the collection of source material, where it becomes necessary to carry out research (of a secondary or primary nature) that identifies specific quantitative relationships, regularities and associations governing certain consumer behaviour in the market. This is possible with the use of appropriate patterns, i.e. formal records of the mapped regularities. Depending on whether the subject of the mapping is a process, a physical object or a structure, network systems, flowcharts or mathematical models are used (Mynarski, 1982; Lange, 1978, p. 105),

- identification of the types of variables underlying the models being built. This identification includes elements related to the consumer's environment and constituting the consumer's perceived capabilities, his/her motivation to engage in certain activities and the couplings occurring between the various elements of behaviour (Kahneman, Tversky, 2000, p. 79). The source of identification is the environment of the system, i.e. the environment in which reactions and stimuli occur and the source of the external supply of information, energy and matter. Elements (e.g. energy processes, symbols, physical objects) and the couplings between them from the point of view of changes in environmental states are also the subject of identification. Each individual element is identifiable if it has at least one external input. Furthermore, it should be noted that an element coupled to an identifiable element is identifiable (Smyczek, 2016, pp. 344-345) and elements coupled both in series and in parallel with identifiable elements are also identifiable (Kiezel, 2010, p. 227). In addition to identifiable elements, weakly identifiable or unidentifiable elements are also indicated in the system. Identifiable elements are distinguishable in the system, while non-identifiable elements are not. Moreover, the important elements of a system built by consumer behaviour and the environment are also the couplings that make up a given structure and can take the form of dependencies, relationships, interactions and linkages. To the category of variables used in models of consumer behaviour, one should also add intervening variables that operate between responses and incentives modifying the relationship between them, but which cannot be directly observed and measured. This way, endogenous data is obtained, which can have an internal and external source. The traceability of a system is the basis for the cognisability of its elements and of the couplings that make up its structure, since the impossibility of identification does not allow the statistical determination of structural parameters and the judgement of whether there are distinct structures whose assessments with equal reliability can appear in the sample (Heesterman, 1975);
- modelling, i.e. the graphical representation of the elements of the whole system, where the key becomes capturing the relationships between the elements of the system that make up consumer behaviour and the links between these behaviours and the environment (Lambkin, 2001, p. 265);
- verification of the model, which in practice can only consist in verifying the theories and laws underlying the model under construction. In all cases of verification, the progressive concretisation must go so far as to allow confrontation with reality (Smyczek, 2007, p. 110).

## 5. Summary

According to T. Wachowicz (2016, p. 413), there are many methods of compensation analysis that differ in their formal assumptions or philosophy of aggregating single-criteria assessments into a multi-criteria evaluation.

In summary, the presented analytical approach and procedure for investigating multi-criteria selection problems are universal. They can be applied directly to support problems with different decision-making contexts and in analytical work related to the ordering of objects or the construction of a multi-criteria ranking on the basis of some resultant synthetic criterion (Wachowicz, 2016, p. 420).

The SPACE method is not one of the most popular analyses used, but it is an extremely valuable and helpful tool for selecting or revising a company's strategy. It makes it possible to identify strategic problems occurring in the area of company operation from the point of view of two objectives (Moszkowicz, 2000, p. 60):

- to assess whether or not the company's existing strategy needs to be changed,
- to decide what changes should be made.

The fundamental problems of the verification procedure are the problem of practical identification and the problem of the degree of correspondence required. Practical identification requires determining which elements of actual market behaviour are equivalent to the theoretical categories, i.e. it is necessary to identify those specific elements of reality that are recognised as equivalent to the theoretical categories of behaviour. Once the theoretical categories of consumer behaviour have been identified in practice, it is necessary to verify the regularities present in these behaviours, which is done by confronting them with the actual course of consumer behaviour on the market and by finding conformity with the regularities present in this course. However, this correspondence is never complete, as the practical identification of consumer behaviour is always only approximate, and theories of behaviour only show the relevant relations between theoretical categories, while the actual course of behaviour is always concrete (Raymond, 2003, p. 37). Verification of the regularity of consumer behaviour in the market is only possible when confronted with mass processes occurring in reality and not with individual cases (Lange, 1952, pp. 20-21).

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## ASSESSING THE DEVELOPMENT OF CULTURAL INSTITUTIONS IN POLAND – A MULTIDIMENSIONAL COMPARATIVE ANALYSIS

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**Purpose:** The main goal of this paper is to assess the development of cultural institutions in Poland. It examines the application of selected statistical methods which have not been applied as yet for the purpose of ranking cultural institutions. To achieve this goal we identified the most appropriate variables which, in our opinion were the most adequate to describe the development of cultural institutions. We used selected linear ordering procedures and processed statistical data on cultural institutions in Poland.

**Design/methodology/approach:** Based on the review of literature on the role of cultural institutions in a broader socio-economic landscape the authors present the application of three statistical methods: Perkal, Hellwig and TOPSIS.

**Findings:** The study managed to review the development of musical cultural institutions in terms of the analysis of the spatial differentiation factor. We demonstrated how the three selected methods of statistical analysis can be used for ranking cultural institutions. Thus, we contributed to the research on the measurement of challenges posed by the intangible nature of creative industries.

**Originality/value:** In the study, linear ordering methods were used to assess the development of musical cultural institutions, which had not previously been used to create rankings of cultural institutions. No such application of statistical methods was applied so far to rank cultural institutions within the context of the creative sectors development.

**Keywords:** cultural institutions, creative sectors, multidimensional comparative analysis, measurement of output in cultural institutions.

**Category of the paper:** an empirical study.

### Introduction

„Culture is universally recognized as a driving force for economic and social development, for sustainability as well as for developing a sense of belonging to a common space such as that of Europe” (European Union, 2022). According to UNESCO, culture is a vehicle for economic

development (UNESCO, 2010) but also a vehicle for environmental stability and resilient communities. Not surprisingly culture has its contribution to the economic development. Therefore, the development of cultural institutions can and should be a subject of economic studies, especially that the role and share of creative sectors in overall economic activities is growing in virtually all developed countries. For example, in Poland in 2018 creative economy was responsible for 6.3% of economic value added, 15% of economic growth in Poland in the earth 20/15/2018 can be attributed to the creative economy (Bąkowska et. al, 2020).

There has been a growing need in the Creative and Cultural Industries (CCI) sector to prove their 'worth' by demonstrating efficiency and effectiveness in economic or other fields in society. Cultural institutions are a specific type of organisation whose aim is to preserve, interpret and disseminate cultural, scientific, and environmental knowledge, and promote activities meant to inform and educate citizens on associated aspects of culture, history, science and the environment. The most popular cultural institutions are museums, libraries, historical or botanical societies, and community cultural centres. A cultural institution or cultural organization is an organization within a culture/subculture that works for the preservation or promotion of culture (Amruta, 2023). Cultural institutions are characterised by an acknowledged mission which makes them distinct from other organizations within the creative sectors. Their contribution is measured to large extend by intangible factors such as their contribution to the conservation, interpretation and dissemination of cultural, scientific, and environmental knowledge. Cultural institutions are play an important role in prompting cultural understanding, intercultural dialogue and cultural diversity, and in the transmission of culture across generations. According to Krajewski (2021) cultural institutions are a product of modernization processes that sprouted in the eighteenth century and matured after World War Two. Cultural institution, especially according the European tradition are supposed to be financed mainly from the public, rather than private funds (Krajewski, 2021).

## Research problem

We focused our research on the issue which has been present in the literature for several decades, namely: „How to value cultural institutions or activities?”. The question of economic contribution to the economy became a focal point of the neoliberal economic thinking (see for example: Myerscough 1988). At present, there is a tendency to consider the value of culture as something quite more complex and holistic, particularly the social aspects, which cannot be reduced to a monetary form (Alberti, 2021).

As in many other countries, the spatial distribution of cultural institutions in Poland is uneven. The chief authorities responsible for organizing cultural activities at regional level are voivodships (NTS-3) in Poland, due to the current distribution of powers between the three



levels of local governments. Cultural institutions strive to increase number of consumers of their offerings, often on competitive basis with other cultural institutions. We narrowed down the scope of our study only to musical institutions. The aim of our paper is to identify the most appropriate variables which are the most adequate to describe the development of cultural institutions. In order to achieve that goal we will use selected linear ordering procedures and process statistical data on cultural institutions in Poland. We used three methods of linear ordering, namely: Perkal, Hellwig and the TOPSIS linear ordering method.

We were able to identify some publications related to the financing of cultural institutions in Poland, e.g. the GUS Report on methodological work (GUS, Satellite Culture Account or Culture Statistics Report. Methodological notebook). However, there is still a research gap in the field of research on the statistical analysis of development with particular emphasis on musical cultural institutions, which is why the scope of our study narrows the broad area of research on cultural institutions to music institutions.

## Research approach

Cultural institutions, and in a broader sense, cultural industries are characterised by a platheora of variables including spatial distribution, economic performance and financing (both from public and private sources), artistic performance, creativity assessment etc. Additionally, the diversity of forms of artistic expression (music, theatre, dance, poetry, painting - to name just a few) makes all comparisons a challenging research task. We decided to apply some multidimensional statistical methods to provide some more evidence on how to rank cultural institutions. The most adequate seem to be taxonomic methods, the linear ordering method in particular. The linear ordering methods measures sets of statistical data – objects or phenomena described by numerous variables. The application of a synthetic index allows to identify the variance of a spatially diversified factor. Linear ordering methods are used to classify multi-attribute objects are useful for prioritisation – ranking of regions, institutions, organisations or products.

The Perkal, Hellwig and TOPSIS linear ordering methods allow for comparisons of selected indices and obtaining a synthetic measure for describing the regional development. The Hellwig method uses a benchmark as a point of reference in a multidimensional space. The TOPSIS method uses two points of reference: a positive benchmark and a negative benchmark. When applying the linear ordering methods the following steps have to be followed (Bąk, 2016):

1. choose the appropriate variables,
2. determine the role of the variables: stimulants, destimulants or nominants,
3. attribute weights to variables,

4. normalise the variables,
5. in the case of (benchmark aggregation) set the index for the benchmark indicator,
6. perform benchmark or non- benchmark aggregation,
7. conduct qualitative assessment of the data set and develop synthetic variables.

## Data collection

We selected data from the Polish Statistical Office (GUS), Bank of Local Data (BDL). We used data from 2018 due to our pre-set condition that we would investigate the phenomenon before the outbreak of the COVID-19 pandemic as 2018 was the most recent year of a stable and undisturbed full year when musical institutions could function within the traditional mode.

We selected 12 variables characterising musical institutions and theatres and two variables characterising the population of each voivodship in 2018 (Table 1).

**Table 1.**

*Variables characterising the development of cultural institutions*

Symbol	Variable name	Unit	Year
X1	Music institutions - units - philharmonic	quantity	2018
X2	Music institutions - performers / concert (at fixed room) - philharmonic	quantity	2018
X3	Music institutions - audiences / learners (at fixed room) - philharmonic	person	2018
X4	Music institutions - units - symphony orchestra and chamber	quantity	2018
X5	Music institutions - performers / concert (at fixed room) - symphony orchestra and chamber	quantity	2018
X6	Music institutions - audiences / learners (at fixed room) - symphony orchestra and chamber	person	2018
X7	Theatres - units - entertaining musical theater, operetta - theater, dance, ballet, musical	quantity	2018
X8	Theatres - performances in fixed theater halls - performances - entertaining musical theater, operetta - theater, dance, ballet, musical	quantity	2018
X9	Theatres - performances in fixed theater halls - audience - entertaining musical theater, operetta - theater, dance, ballet, musical	person	2018
X10	Theatres - units - opera theater	quantity	2018
X11	Theatres - performances in fixed theater halls - performances - opera theater	quantity	2018
X12	Theatres - performances in fixed theater halls - audience - opera theater	person	2018
X13	Number of inhabitants in voivodeships	person	2018
X14	Number of inhabitants in voivodeships per 100,000 people	person	2018

Source: GUS-BDL: <https://bdl.stat.gov.pl/bdl/dane/podgrup/wymiary>, 21 February 2023.

After initial calculation and analysis the variance indicator was calculated. The number of variables was reduced to 5 through combining the variables characterising of musical institutions with opera theatres due to the error in the GUS data which did not classify one cultural institution (Opera nd Philharmony in Białystok) as a musical institution but as a opera theatre showing „zero” for the number of concerts and participants in Podlaskie Voivodship which is not correct because the institution organises both opera performances and a symphonic

concerts. The GUS data only reveal the Cameral Philharmony in Łomża (Filharmonia Kameralna im. Witolda Lutosławskiego w Łomży), which should belong to the musical institutions indicator – „symphony orchestra and chamber”. The selected variables are indicated in Table 2.

**Table 2.**  
*Variables selected for the study*

<b>X1</b>	Music institutions - units - philharmonic and opera theater	quantity	2018
<b>X2</b>	Music institutions - performers / concert (at fixed room) - philharmonic and opera theater	quantity	2018
<b>X3</b>	Music institutions - audiences / learners (at fixed room) - philharmonic and opera theater	person	2018
<b>X4</b>	Music institutions - units - symphony orchestra and chamber	quantity	2018
<b>X5</b>	Music institutions - performers / concert (at fixed room) - symphony orchestra and chamber	quantity	2018

Source: GUS-BDL: <https://bd1.stat.gov.pl/bdl/dane/podgrup/wymiary>, 21.02.2023.

When selecting variables one has to calculate the arithmetical average, standard deviation and most importantly, the variance indicator. Which plays the key role in determining the variance of variables. The calculated variance indicator is above 45%, which indicates a strong variance of variables. Data presented in relative units are included in Table 3.

**Table 3.**  
*Data in relative unit*

<b>Voivodeship</b>	<b>X1</b>	<b>X2</b>	<b>X3</b>	<b>X4</b>	<b>X4</b>
dolnośląskie	0.137809999	22.08405239	9587.269388	0	0
kujawsko-pomorskie	0.096017944	12.4823327	6324.26988	0.048008972	2.784520371
lubelskie	0.047029676	6.113857905	2570.877249	0.047029676	1.834157372
lubuskie	0.196689325	28.51995217	6247.541383	0	0
łódzkie	0.080765169	9.651437721	6924.240252	0	0
małopolskie	0.058973043	9.936957817	4294.210616	0.088459565	2.919165649
mazowieckie	0.074285692	8.189997543	6786.59225	0.074285692	1.652856647
opolskie	0.101003061	13.73641635	5312.054008	0	0
podkarpackie	0.046967364	4.274030147	1786.779438	0	0
podlaskie	0.168840773	37.82033316	9489.780068	0	0
pomorskie	0.129073839	25.6426694	11234.4579	0.086049226	0.688393809
śląskie	0.087947267	13.96162861	3534.578667	0.087947267	8.640818965
świętokrzyskie	0.080145416	9.938031564	2637.425345	0	0
warmińsko-mazurskie	0.069737682	12.62252039	4424.298003	0.069737682	0
wielkopolskie	0.085979348	9.486388036	3941.780518	0.028659783	0.171958696
zachodnio-pomorskie	0.175898092	29.49224671	11361.08184	0	0
average	0.102322731	15.87205329	6028.5773	0.033136116	1.168241969
standard deviation	0.05	9.764498494	3052.993454	0.037519767	2.246504389
coefficient of variation	45.17%	61.52%	50.64%	113.23%	192.30%

Source: own elaboration.

The next step in our research procedure was to develop a matrix of the Pearson linear correlation coefficients (Table 4).

**Table 4.**  
*Pearson linear correlation coefficient matrix*

	X1	X2	X3	X4	X5
X1	1	0.933546611	0.739884673	-0.404602	-0.257146405
X2	0.933546611	1	0.782997822	-0.264626256	-0.207389325
X3	0.739884673	0.782997822	1	-0.109761938	-0.26880222
X4	-0.404602	-0.264626256	-0.109761938	1	0.637239684
X5	-0.257146405	-0.207389325	-0.26880222	0.637239684	1

Source: own elaboration.

At the conclusion of the variables selection process one needs to calculate a reverse matrix to the Pearsons correlation matrix so that the elements on the main diagonal of the reverse matrix are lower than the assumed critical value of 10 (Table 5).

**Table 5.**  
*Matrix inverse of Pearson's linear correlation coefficient matrix*

	X1	X2	X3	X4	X5
X1	10	-8.397034681	-1.119200265	2.468953392	-0.934683901
X2	-8.397034681	9.7792964	-1.524215245	-1.0645156	0.137493549
X3	-1.119200265	-1.524215245	3.156205209	-1.120588192	0.958573937
X4	2.468953392	-1.0645156	-1.120588192	2.56312329	-1.520427154
X5	-0.934683901	0.137493549	0.958573937	-1.520427154	2.014707411

Source: own elaboration.

In the study, despite the value on the main diagonal equal to 10, the X1 variable was left for substantive reasons. The selection of variables allows the analysis of data using linear ordering methods.

**The Perkal method** involves the development of a synthetic index combining a sum of standardised partial indicators and includes the following stages:

Stage I: Determining the character of variables (stimulant/destimulant).

Stage II: Standardisation - converting destimulants into stimulants (1).

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \text{ for stimulant} \quad (1)$$

$$z_{ij} = -\frac{x_{ij} - \bar{x}_j}{s_j} \text{ for destimulant}$$

Stage III. Determining the synthetic index (2):

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

where:

WP – value Perkal,

n – number of objects,

$z_{ij}$  – standardized value  $j$  variable in the object  $i$ ,

Stage IV. Then you need to rank the objects (Table 6).

**Table 6.**  
*Voivodeship ranking*

Voivodeship	WP	Rank
		1
		2
		3
		4
		5
		6
		7
		8
		9
		10
		11
		12
		13
		14
		15
		16

Source: own elaboration.

Stage V. The last stage of the Perkal method is the classification of objects presented in Table 7).

**Table 7.**  
*Classification of the level of development*

Classes	Development level	Formula
I	Very high	$WP > \text{average} + \text{standard deviation}$
II	High	$\text{average} \leq WP < \text{average} - \text{standard deviation}$
III	Low	$\text{average} - \text{standard deviation} \leq WP < \text{average}$
IV	Very low	$WP < \text{average} - \text{standard deviation}$

Source: own elaboration.

**The Hellwig** linear ordering method involves the development of a synthetic indicator combining the sum of partial standardized indicators. Here, the point of reference for objects in multidimensional space is a benchmark. The method was popularized in the field of taxonomic research in 1968 as the first method of linear ordering for measuring the economic development (Bak, 2016). Similar to the Perkal method, the Hellwig method involves several stages:

Stage I: Determining the type of variable: a stimulant/destimulant and determining the maximum and minimum values of objects.

Stage II. Standardization –  $z_{ij}$  and determining a coordinating benchmark –  $z_{0j}$

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j} \quad (3)$$

$$z_{0j} = \begin{cases} \max_i \{z_{ij}\} & \text{for stimulant variables} \\ \min_i \{z_{ij}\} & \text{for destimulant variables} \end{cases}$$

Stage III. Determining the distance between the objects and the benchmark:

$$d_{i0} = \sqrt{\sum_{j=1}^m (z_{ij} - z_{0j})^2} \quad (4)$$

Stage IV. Determining the synthetic indicator:

$$q_i = 1 - \frac{d_{i0}}{d_0} \text{ synthetic indicator}$$

$$\bar{d}_0 = \frac{1}{n} \sum_{i=1}^n d_{i0} \text{ average distance from the benchmark} \quad (5)$$

$$s_d = \sqrt{\sum_{i=1}^n (d_{i0} - \bar{d}_0)^2} \text{ standard deviation}$$

$d_0 = \bar{d}_0 + 2s_d$  the sum of the average distance and the double standard deviation

Stage V. Ranking the objects.

Stage VI. Classifying the objects– as in the Perkal method.

The TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) – supports decision-makers in ordering multi-criteria options. The method was developed and published by Ching-Lai Hwang and Kwangsun Yoon (Hwang, Yoon, 1981) in a paper on multicriteria decision-making.

The TOPSIS method involves the development of a synthetic indicator combining the sum of partial standardised indicators. The method uses two points of reference, the so called ideal solution and the anti-benchmark as the reference points for decisions (Hwang, Yoon, 1981).

The methods involves six stages:

Stage I. Determining the type of variable: a stimulant/destimulant and determining the maximum and minimum values of objects – as in the Hellwig method.

Stage II. Normalising variables (6):

$$z_{ik} = \frac{x_{ik} - \min_i \{x_{ik}\}}{\max_i \{x_{ik}\} - \min_i \{x_{ik}\}} \text{ for stimulant}$$

$$z_{ik} = \frac{\max_i \{x_{ik}\} - x_{ik}}{\max_i \{x_{ik}\} - \min_i \{x_{ik}\}} \text{ for destimulant} \quad (6)$$

where:

k – indicator number (k = 1, 2, ..., m),

i – voivodeships number (k = 1, 2, ..., 16),

$\max_i \{x_{ik}\}$  – maximum value of the k-index,

$\min_i \{x_{ik}\}$  – minimum value of the k-index.

Stage III. Determining the Euclidean distance of objects from the points of reference (7).

$$\begin{aligned} d_i^+ &= \sqrt{\sum (z_{ik} - z_{ik}^+)^2} \\ d_i^- &= \sqrt{\sum (z_{ik} - z_{ik}^-)^2} \end{aligned} \quad (7)$$

where:

$z_{ik}^+ = (1, 1, \dots, 1)$  – positive benchmark of development,  
 $z_{ik}^- = (0, 0, \dots, 0)$  – negative benchmark of development,  
 $k = 1, 2, \dots, m$ ;  $I = 1, 2, \dots, n$ .

Stage IV. Determining the synthetic indicator (8).

$$q_i = \frac{d_i^-}{d_i^- + d_i^+} \text{ synthetic indicator} \quad (8)$$

Etap V. Facility ranking.

Etap VI. Classification of objects - as in the Perkal method.

## Results and discussion

As shown in table 3. the application of each of the 3 methods reveals a different order of Polish regions depending on the ranking method applied (Table 9).

**Table 9.**  
*Voivodeship ranking*

<b>Voivodeship</b>	<b>Rank Perkal</b>	<b>Rank Hellwig</b>	<b>Rank TOPSIS</b>
dolnośląskie	6	7	6
kujawsko-pomorskie	7	5	9
lubelskie	14	14	13
lubuskie	5	6	5
łódzkie	12	13	12
małopolskie	9	9	7
mazowieckie	8	8	8
opolskie	11	11	11
podkarpackie	16	16	16
podlaskie	3	3	3
pomorskie	1	1	1
śląskie	2	2	2
świętokrzyskie	15	15	15
warmińsko-mazurskie	10	10	10
wielkopolskie	13	12	14
zachodniopomorskie	4	4	4

Source: own elaboration.

The results obtained by applying the Perkal method are presented in Table 10.

**Table 10.**  
*Method classification of Perkal*

Voivodeship	WP	Classes
pomorskie	0.896261081	I
śląskie	0.692713939	I
podlaskie	0.68351489	I
zachodniopomorskie	0.66606476	I
lubuskie	0.401139211	II
dolnośląskie	0.23329854	II
kujawsko-pomorskie	0.145829873	II
mazowieckie	0.033472045	II
małopolskie	0.028003466	II
warmińsko-mazurskie	-0.221566203	III
opolskie	-0.377031026	III
łódzkie	-0.442667656	III
wielkopolskie	-0.450782475	III
lubelskie	-0.532320851	III
świętokrzyskie	-0.720306535	IV
podkarpackie	-1.035623057	IV

Source: own elaboration.

Research results in the application of the Hellwig method (Table 11).

**Table 11.**  
*Method classification of Hellwig*

Voivodeship	qi	Classes
pomorskie	0.443173763	I
śląskie	0.412367182	I
podlaskie	0.365281002	II
zachodniopomorskie	0.362413275	II
kujawsko-pomorskie	0.3494308	II
lubuskie	0.322010619	II
dolnośląskie	0.310206382	II
mazowieckie	0.2649545	II
małopolskie	0.257299496	II
warmińsko-mazurskie	0.189277514	III
opolskie	0.186477596	III
wielkopolskie	0.161424293	III
łódzkie	0.158433392	III
lubelskie	0.1289813	III
świętokrzyskie	0.093403478	IV
podkarpackie	-0.001258085	IV

Source: own elaboration.

Test results using the TOPSIS method are presented in Table 12.



**Table 12.**  
*Method classification of TOPSIS*

Voivodeship	qi	Classes
pomorskie	0.598620893	I
śląskie	0.530935771	I
podlaskie	0.513534451	II
zachodniopomorskie	0.512871854	II
lubuskie	0.461826188	II
dolnośląskie	0.424786842	II
małopolskie	0.410061815	II
mazowieckie	0.401604757	II
kujawsko-pomorskie	0.387888588	II
warmińsko-mazurskie	0.343705662	III
opolskie	0.243795833	III
łódzkie	0.243489912	III
lubelskie	0.235011535	III
wielkopolskie	0.215735444	III
świętokrzyskie	0.125829485	IV
podkarpackie	0	IV

Source: own elaboration.

To compare the results the Spearman co-relation index was used. With the values close to 1.00 for each variance a strong interdependence is present. The strongest correlation is observed between the Perkal and the Hellwig methods (Table 13).

**Table 13.**  
*Spearman's rank correlation*

<b>Perkal Rank</b>	<b>Rank Hellwig</b>	0,988235294
<b>Perkal Rank</b>	<b>Rank TOPSIS</b>	0,985294118
<b>Hellwig Rank</b>	<b>Rank TOPSIS</b>	0,958823529

Source: own elaboration.

According to the Perkal and Hellwig rankings, Pomorskie and Śląskie regions score high in the ranking of musical institutions in Poland. The former scores high with the highest number of spectators in another philharmonic and theatre operas. This result may be explained by a large number of tourist resorts in the region providing seasonal participants including tourists and patients who participate in cultural offering as a part of their leisure time. The Śląskie region has more cultural institutions than the Pomorskie region including such prominent institutions as the Silesian Philharmony in Katowice and Silesian Opera in Bytom, Zabrze Philharmony in Zabrze, Częstochowa Philharmony in Częstochowa as well as many renowned symphonic and chamber orchestras: NOSPR – Polish Radio National Symphonic Orchestra in Katowicach, Zespół Pieśni i Tańca „Śląsk”. The key success factor for the Śląsk region is nick character of NOSPR. The new modern facilities draw attract art lovers not only music fans but also lovers of architecture. According to Yasuhis Toyota the popularity of cultural institutions can we explain when at visitor is able to see there's something which he will never see anywhere else in the world” (Siedziba NOSPR).

The following seven regions which scored high in the a ranking of cultural institution development include: Podlaskie, Zachodniopomorskie, Kujawsko-pomorskie, Lubuskie, Dolnośląskie, Mazowieckie and Małopolskie. The oldest opera and philharmonic theatres in Poland are located in those regions as well as those who received their high status more recently such as Szczecin Philharmony and the National Forum of Music in Wrocław.

The low and very low level of development was achieved by those regions where the number of spectators in a permanent stage is compared to the number of inhabitants. The explanation can be different income levels in Polish regions, with Eastern Poland being substantially poorer than the West of the country. In 2018 the lowest disposable income in Poland was in Podkarpackie region, located in the South east of the country - PLN 1347. A similar situation can be observed in other Eastern Poland regions such as: Świętokrzyskie and Lubuskie. Low income levels exclude many people from accessing cultural goods which usually are at the top of the Maslow pyramid of needs. A smaller number of culture introductions in a given region for example in Świętokrzyskie or Podkarpackie can be explained also by a smaller number of performances and concerts (in a permanent hall) or in an opera cross theatre. Geographical networks connecting big cities with other metropolitan centres allow for easier access to cultural institutions located in other regions. Such opportunities are limited to the inhabitants of smaller towns and cities which will have a smaller selection of metropolitan areas and the cultural institutions than the inhabitants of larger metropolitan areas. On the other hand, the inhabitants of Eastern Polish regions might have relatively easy access to the cultural institutions in the neighbouring metropolitan areas such as Warsaw or Kraków. Unfortunately there is no data available regarding the geographical origin of the spectators in specific cultural institutions in Poland. Another factor impacting the consumption of cultural services in Poland is that the artistic seasons in musical institutions in Poland start on the 1st of September and finish on the 31st of August the following year. There is only a limited number of events and performances organised during the holiday. Such timetable may have negative impact on the participation in culture in Poland as most of the cultural institutions in Poland are closed during the holiday.

## Summary

By analysing the results of the application of three linear ordering methods, namely the Perkal, the Hellwig and the TOPSIS methods for the purpose of measuring the development of cultural institutions certain findings can be observed. There is a co-relation between the number of cultural institutions in Poland and the variety of offerings. A more diversified offer of cultural institutions co-exists with a better access to musical institutions which in turn results in an increased number of spectators. It has to be emphasised that the development of musical

cultural institutions is not only explained by the offering of Philharmonic operas and musical theatres but also very diversified. The architecture of the facilities also has a positive impact on the number of spectators. Good examples illustrating the architecture of some prominent Polish cultural institutions include the NOSPR in Katowice and the Philharmony in Szczecin.

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## ON ANALYSIS OF GREEN ENERGY PORTALS/APPLICATIONS IN PEOPLE'S REPUBLIC OF CHINA, SPAIN, POLAND AND TÜRKIYE FOR SUSTAINABLE DEVELOPMENT OF SOCIETY

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**Purpose:** The primary goal of this article is to compare the role of green energy portals/applications in shaping sustainable societies in selected countries: the People's Republic of China, Spain, Poland, and Türkiye.

**Design/methodology/approach:** The comparisons were made for data collected at the turn of 2022/2023, in the PRC, Spain, Poland and Türkiye. The data was collected using a CAWI survey distributed in the academic environment of the countries analyzed in the study, supplemented by statements obtained through mailing lists and social media platforms. The study included 1209 people, of which a total of 608 individuals completed the entire survey questionnaire. Differences in the obtained results were evaluated using Euclidean distance. The hypothesis was made about the existing differences between the average ratings of attributes of individual green energy portals/applications and it was proven to be true for the Poland-Türkiye, Poland-PRC, and Poland-Spain relationships, but not for the pairs of other countries. Portal/application ratings were made using a scoring method and the proprietary conversion method.

**Findings:** Respondents in all analyzed countries use information technology infrastructure on a daily basis to communicate with the Internet (by smartphones and PCs): in the PRC, Türkiye, Poland and Spain, 53% of the surveyed people are very familiar with and well-versed in issues related to green energy, and they have the greatest knowledge about it.

**Research limitations/implications:** The limitation of the study was that it was mainly conducted in the academic environment of selected countries. Its most important achievement is the comparison of opinions on the use of green energy portals for countries that are so different culturally, economically, and demographically.

**Practical implications:** Practical implications of the study may be useful for business practitioners in selected countries to indicate possible strategies for designing green energy portals/applications that support the creation and development of a sustainable society as well as showing the method of using these results.

**Originality/value:** The value of the research was achieved by creating a pattern to follow, pre-design analyses, as a guideline for analysts and designers of portals, for establishing functionality and HCI techniques and for comparing methods used to evaluate modern ICT.

**Keywords:** green energy, sustainable society, green energy portals/applications, international comparative study, methods of evaluating services.

**Category of the paper:** Research paper.

## 1. Introduction

The main objective of the article is a comparative analysis of the potential role of portals/applications related to green energy in shaping a sustainable society in selected countries: the People's Republic of China, Spain, Poland and Türkiye. Sustainable social development refers to a situation where economic and social development is based on a balance between consumption and investment, with full awareness of the limitations of natural resources and the non-renewability, or difficult renewability, of some of them on a global scale. This leads to the support for real income growth, raising the level of education, and improving both public health and quality of life (Pearce et al., 1989). Sustainable development goals are therefore formulated for the three interconnected spheres related to economic, social and environmental dimensions (Keiner, 2005). At the same time, all these spheres should develop harmoniously, simultaneously and in an integrated manner, in order to meet social requirements and expectations, economic efficiency, and the highest possible level of environmental protection (The Future We Want, 2012). In the social sphere, such development aims to ensure universal prosperity (combating poverty, ensuring gender equality and intergenerational equality through economization and cooperation) and an increase in awareness, culture, and the need for pro-environmental action in the face of the increasing threat to life on Earth. In the economic sphere, efforts are focused on long-term economic profit and loss accounting in comparison to ecological solutions supported by the development of ecological technologies, eco-friendly economy, reducing waste (slow instead of fast economy) and financial burden for environmental pollution directed towards its remediation. In the ecological sphere, there is a focus on transforming technologies to be environmentally friendly and to support the conservation of its most valuable resources, limiting the extraction of non-renewable resources (alternative technologies - green energy or concessions), etc.

An ecological crisis occurs when changes in the environment (climate) or population (natural or social areas) begin to show symptoms that threaten their survival. The perceived impacts mostly refer to previously unnoticed intense heat waves, violent winds (cyclones, tornadoes), melting glaciers, rapid and prolonged rainfall and related flooding, massive deforestation, coral reef ecosystem degradation, food insecurity, species extinction, etc. Preventing these adverse changes (Climate Change..., n.d.) requires long-term economic and social policies. Counteracting these unfavorable trends is not easy and simple because it takes time, especially in terms of the general awareness. Such initial conditions as, for example, existing carbon dioxide emissions, or the lack of knowledge on the subject among the public, or the deliberate ignoring of it among a ruling class primarily interested in production efficiency, cannot be overcome overnight. The first serious warnings of the possibility of stunted development due to resource depletion from the 1970s (Meadows et al., 1972) have caused a shift towards the realization of sustainable development, but not for long. It seems that warnings about climate change still face obstacles regarding the policies of governments and corporations, in addition to the lack of awareness of its effects being undermined by a lack of knowledge and a lack of integration of environmental action. They are also sometimes countered by crises (where the economy seems more important), although, on the other hand, the reduction of oil supplies by Russia to Western Europe, after sanctions were imposed on that country following its attack on Ukraine, has led to an increase in interest in green energy sources. Therefore, any activity that raises awareness of this issue, especially on social media, most popular among the young Generation Z, is worth a thorough investigation and the results of such analyses should be presented and disseminated. One of the most commonly used tools for this purpose are portals/web applications. Their quality, measured according to various criteria, can attract or discourage users. Therefore, it is important that these tools meet users' requirements as much as possible, especially in such an important area as the promotion of the idea of green energy, which is the basis for the broadest current environmental activities. The patterns of portals/web applications in this field can be as varied as the cultural, social and economic conditions as well as the conditions directly related to crises or to health and political threats.

Do the existing and most popular portals/applications in the analyzed countries meet the identified criteria regarding their impact on informing and propagating green energy and sustainable actions for society? Are there methods to evaluate their usefulness that support decision-making in ways which are transparent and easy to accept in the pursuit of a sustainable society?

Analyses of their usefulness in this area are rarely found in the literature, since studies tend to focus on investigating the impact of ICT on the development of green energy (Collados-Lara et al., 2022). The research also focuses more on: comparisons of 'clean' energy suppliers (CleanTech..., n.d.), the use of renewable energy sources and strategies in the country in relation to the global economy or other countries (Arioğlu Akan et al., 2015; Muhammed,

Tekbiyik-Ersoy, 2020; Effatpanah et al., 2022), comparison of renewable energy deployment options (Shatnawi et al., 2021). The importance of the methods used for analyzing the obtained results should not be underestimated. In a number of studies, simple scoring methods were used, while multi-criteria methods were only applied in a specific case of *comparative* evaluations of hypothetical nuclear *energy* system (NES) options (Application of Multi-Criteria..., 2019).

Therefore, a research gap arose, which this article partially attempts to fill in terms of comparative analysis of the usefulness and usability of internet portals/applications in shaping awareness of the need to use green energy and sustainable society in the selected countries.

To achieve this goal, the following structure of the article was adopted. The Introduction presents the essence of the research problem, identifies the research gap, and presents the article's objectives. The second section contains a literature review on green energy in a sustainable society and multicriteria comparative methods. The third section covers the research procedure and presents the sample. In the next part of the article, the analysis and discussion of the results are presented, abbreviated in the case of awareness research on the existence and use of green energy sources in the economy. The same part presents a full comparative analysis of the most popular and most frequently visited portals/applications for each of the selected countries. The Conclusions section contains conclusions and recommendations resulting from the research and discussion, as well as the limitations of the study and directions for further research.

## 2. Literature Review

The concept of striving for sustainable development of society in relation to information and communication technologies (ICT) sets goals in dimensions such as (Ziemba, 2016; Elliott, 2006; Hopwood et al., 2005):

- ecological dimension – ICT impacts the environment through a unique dematerialization of service and consumption processes, minimizing the use of natural resources, waste production and pollution,
- economic dimension – ICT enables increased production efficiency and productivity, optimization of distribution, generating higher incomes and reducing poverty,
- political dimension – ICT allows the entire society to enjoy civil, economic, political, and cultural freedoms through clearly and coherently specified procedures of state and territorial administration and unrestricted dissemination of information,
- social dimension – ICT provides wide access to information about healthcare, education, vocational training systems, high levels of ethical and non-exploitative employment, and participation in shaping a democratic society,



- cultural dimension – ICT presents a wide range of compromise choices among cultural diversity, and commonly recognized principles supported by ICT,
- technological dimension – refers to the efficient and rational use of ICT to integrate the remaining dimensions and support sustainable development of society.

Among such extensive ICT tasks, it plays a special role in creating and developing a sustainable society. Social transformations are a long-term, complex processes which have many, frequently conflicting goals. The subject of the article addresses the role of ICT in shaping awareness of the need for sustainable development, mainly in the field of energy transformation, i.e. replacing conventional sources of energy with so-called "green energy" sources - using typical tools of information dissemination, such as web portals/applications.

The term "green energy" refers to all sources of energy that do not pollute the natural environment and come from quickly replenishing (renewable) resources such as the sun, wind, water, biomass (Toombs, 2021). Their use for energy production does not cause the consumption of raw materials or the degradation of the environment, as during the use of conventional fuels. Therefore, it is classified as "clean" energy. Nuclear energy, which does not emit greenhouse gases, also does not pollute the environment, but it relies on rare and limited resources, making it clean but not renewable. The literature also mentions the category of sustainable energy sources, which create benefits not only ecological but also economic and social. However, not every green energy, or its use, is sustainable, as the conditions for balanced, integrated development in these three areas must also be met. All of these concepts are commonly used interchangeably, which stresses the role of web portals/applications in social education (Eco-Consciousness and Sustainability, n.d.).

The directions of development related to the replacement of conventional sources of energy by green energy depend on: geographical conditions, natural resources, economic conditions, geopolitical and often military alliances (Mont et al., 2021; Caballero-Morales, 2021; Stiglitz, 2021; Marttunen, Mustajoki, 2018). There are also differences during periods of crises, going through intermediate stages of rationalizing the structure of the energy "mix" from many different sources to optimizing effects, mainly economic ones (Hyman et al., 2021; Ibn-Mohammed et al., 2021). This is not always consistent with sustainable development.

The problem is becoming more and more serious, particularly given that, apart from Spain, which can be a positive benchmark for others (with 42.2% of energy from renewable sources in 2020), the other countries analyzed are not leaders in this area. In Poland, energy is obtained mainly from conventional sources (hard coal (50%), lignite (30%), gas (almost 4%)) - 84% in 2022, and energy from renewable resources is only less than 16% (Produkcja Energii..., n.d.; Produkcja Energii Elektrycznej..., 2022). In Türkiye, it looks very similar in 2021 - 84% of energy was sourced from coal and natural gas (Dierks, 2022), although other sources estimate this share much lower (Cetinkaya, 2022; Uğurlu, Gokcol, 2017). In the PRC, 78% (2021) was energy obtained from coal, gas and oil, and 22% from green energy (cycles & Text, n.d.).

Ecological topics are emerging more frequently in relation to individual countries, as well as at a regional level. They may concern the impact of obtaining energy from non-renewable resources and its effect on agriculture (Rohr et al., 2021), the influence of financial regulations on policies related to green energy (Yoshino et al., 2021), the logistics of the distribution of green energy sources (Wątróbski, 2016) minimizing environmental degradation (Zandi, Haseeb, 2019), or evaluating planning practices for shaping a strategy related to transforming energy into a form which is less harmful for the environment (Kabir, Morgan, 2021). Comparative analysis between countries is much less frequent (Chang et al., 2022) and mainly based on statistical and econometric analyses.

Currently, socio-economic development cannot be achieved without modern technologies. ICT development is particularly important in this regard. This also applies to the broadly understood ecology, as the third necessary "leg" for maintaining sustainable development in balance. This is due to the faster financial growth associated with information technology (Kaakeh et al., 2021) or the development of knowledge concerning new energy sources and optimal ways to use them (Kabir, 2021). The Internet has become one of the most important tools for disseminating this knowledge (Chien et al., 2021). In the online realm, portals and mobile applications are the fundamental tools for spreading information. Their usage may vary in different countries, depending on the path chosen for developing internet access. So far, the most popular method - via personal computers - is gradually being replaced by a cheaper and simpler option, but with more limitations - internet access through smartphones, as evidenced by recent studies. The increased interest in the Internet and environmental issues is also influenced by the recent recurring adverse weather conditions, scarcity of energy resources, or the energy and health crisis in general (COVID-19 pandemic) (Rempel, Gupta, 2021; Jia et al., 2021; Yoshino et al., 2021; Chmielarz et al., 2022b; Chmielarz et al., 2022a). Thus, times of crises are, on the one hand, favorable for the dissemination of the idea of 'green energy', but, on the other hand, due to economic constraints, they can also hamper it. Overcoming these trends is also, among other things, the role of the Internet - showing a reliable, long-term economic account of the advantages of green energy sources over conventional ones could change this situation. Overcoming these trends is also one of the Internet's roles - it could demonstrate the reliable, long-term economic advantages of green energy sources over conventional ones to change this situation.

The issue that remains is that of internet tools for user interaction. Undoubtedly, these include internet services and mobile applications installed on portable devices, primarily smartphones. They come in varying graphic forms, diverse functions, degrees of software complexity, etc. From the user's perspective, however, it is important whether they meet their requirements, interests, the need for knowledge, current trends, and color schemes associated with the content, as well as often such issues as ease of navigation, intuitiveness, user-friendliness, the convenience of use, etc. - attributes of good communication. Caring only about content does not guarantee success (User Experience..., 2019; Nielsen, 1999). This also applies

to green and sustainable portals/apps. A number of methods are used to assess mobile portals/apps, covering a range of attributes relevant not only to the "green energy" information placed on the site, but also to its possible search and a range of parameters that will prompt the user to revisit the site/use the application. In general, simple multi-criteria methods, based on a scoring method or a scoring method with preferences, or other more sophisticated methods are used for this purpose. A comprehensive overview of multi-criteria methods can be found in the publications (Wątróbski et al., 2019; Wątróbski, Jankowski, 2015). The authors, after their experience with multi-criteria methods (Chmielarz, Zborowski, 2020) applied their own Conversion Method based on the data collected in the scoring method in this study. This method is easy to apply in a mass survey (as compared to e.g., the AHP/ANP method) and easy to interpret.

### **3. Methodology**

#### **3.1. Research Procedure**

Research on the role of green energy portals in sustainable societal development was divided into two stages. In the first stage, the level and conditions of awareness of the need to use green energy sources and the role of ICT in this process were determined among respondents from countries that are geographically and culturally distant. In the second stage, the most popular portals and applications related to this topic were identified, their most important attributes for users were specified, they were evaluated by respondents, and international comparisons were made.

Research into the use of ICT in raising awareness of the need for green energy were carried out according to the following procedure:

Stage I:

- agreeing the subject matter and specifics of the research in order to prepare a pilot study, taking into account the regional differences of the partners,
- conducting a pilot study that takes into account the clarity, comprehensibility and importance of survey questions according to the evaluation of a randomly selected group of respondents,
- random selection of student groups in which the survey was conducted,
- making the verified survey available to respondents in particular countries with a request to complete it, (CAWI method),
- analysis of differences in the views of respondents from individual countries and discussion of the obtained results regarding the determination of awareness of the need to introduce green energy sources into the economy.

### Stage II:

- identifying the most popular portal/web applications in each of the countries analyzed,
- specifying the attributes of green energy portals/web applications relevant to their evaluation,
- calculating the differences in the respondents' attitudes to web portals/applications between pairs of individual countries and discussion of these differences,
- testing hypotheses concerning the differences in evaluations of web portal/application attributes based on Fisher-Snedecor statistics,
- summary and conclusions,
- description of the limitations and directions of future research.

The research was conducted from October 2022 to February 2023 simultaneously in four countries: the PRC, Spain, Poland, and Türkiye. The survey consisted of a total of twenty questions, including eighteen survey questions (related to: technical infrastructure for obtaining information about green energy, sources of obtaining information about green energy, awareness of the existence, benefits, and drawbacks of individual renewable energy sources, and two questions regarding knowledge and evaluation of the most popular green energy information portals) and two questions identifying the importance of portals/applications and evaluating the attributes of the most popular portals/applications. The survey included a section related to demographic data containing eight questions that characterized the research sample. The questions were formulated in English, translated into national languages, and then retranslated into English after the survey was conducted. The LimeSurvey tool was used to process the obtained results.

The response rate of the questionnaire reached 51%, which seemed a relatively low proportion, in view of the many prior agreements and the questionnaire being made fully comprehensible by being translated into the national languages.

The Cronbach's alpha coefficient was applied for the reliability analysis. In all analyzed key questions, Cronbach's alpha coefficient indicates the internal consistency and reliability of the sample (Hinton et al., 2004). The internal consistency measure of the 16 dependent variables for the three compared countries, which was based on Cronbach's coefficient alpha, amounted to 0.81 (and 0.88 for Cronbach's alpha calculated based on standardized items), for a total of 20 items.

International comparisons were made based on the Euclidean distance (squares of differences in percentage shares of responses to individual options within specific criteria). The sum of this distance indicated the degree of differentiation between individual countries.

Internet portals were evaluated according to 21 attributes (features of criteria) on a simplified, standardized Likert scale (Likert, 1932) from 0 – the absence of a particular criterion feature up to 1 – complete fulfilment of a particular criterion through intermediate values, divided incrementally by 0.25.

Additionally, the authors formulated the  $H_0$  hypothesis about the existence of differences in the awareness of need for use of green energy between individual pairs of the three analyzed countries: Poland and Türkiye, Poland and the PRC, Poland and Spain, Türkiye and the PRC, Türkiye and Spain and the PRC and Spain in the values regarding individual criteria against the  $H_1$  hypothesis concerning the lack of differences, with the assumed probability of 0.05.

To prove this hypothesis, the significance level of  $\alpha$  was calculated for the probability distribution of the Fisher-Snedecor inverse (right-hand) value. It can be used in the Fisher-Snedecor test to compare the degree of variability of two data sets for two populations and to compare it with the  $p$  value determined based on test statistics. If  $p \leq \alpha$ , then we reject  $H_0$  and adopt  $H_1$ , if  $p \geq \alpha$ , then we reject  $H_0$  and take  $H_1$ .

### 3.2. Description of the research sample

All source data for the analyses were collected at the same time in four locations: University of Warsaw (Poland), Uşok University (Türkiye), University of La Coruña (Spain) and Communication University of China in Beijing (PRC). It was completed via mailing lists and social media platforms, as well as the distribution of paper copies (quick turnaround). The survey covered a total of 1209 people; with an average return rate of 51%, i.e. the results were obtained from 608 people: 99 from Poland, 227 from Türkiye, 162 from China and 120 people from Spain. On average, more than 50% of women and more than 47% of men participated in the survey in these countries and more than 2% declared a different gender or did not wish to declare it. The largest number of women, over 53%, completed surveys in Spain and slightly less in Poland. The largest number of men (55%) were among respondents in Türkiye. The second demographic factor of respondents was age. As the survey was mainly conducted in an academic environment, the age distribution varied, with most respondents (nearly 82%) aged 18-24 years old; over 10% aged 25-34 years old and almost 8% being over 34 years old. The academic community is undoubtedly the most active group of internet users and also the one which is most actively involved in environmental protection (Batorski, 2015). Regulations related to the COVID-19 pandemic have caused, and sometimes enforced, greater activity among older age groups, which is only minimally visible in this study. The age of the respondents, participating in the online survey, and the environment in which it was conducted also influenced their education. As many as 56% of the respondents indicated their education as being incomplete higher education or bachelor's degree, while 34% declared having secondary education level. Approximately 3.5% indicated primary or vocational education, and just under 6% declared having higher education. Analyzing the place of origin of respondents in the case of China required additional procedures. The concept of large, medium, and small cities was clear and equivalent in Poland, Türkiye, and Spain, but had to be adjusted for the PRC (respectively: more than 200 million, 21-200 million, 11-20 million, up to 5 million). The largest group consists of people from big cities (37%) and rural areas (21%). The participation of other groups of respondents is established at between 11-16%.

Social sciences (on average 55%) dominate among the fields of study, and there are also other fields (16%), mainly related to finance, banking, accounting, and logistics. The financial situation of more than half of the respondents is mostly good (32%) and sufficient (21%) or the responses spread between good (average 35%) and average (average 21%). More than 12% declare that they are students and are not financially independent. However, although an average of 66% of respondents declare that they are students or pupils, as can be seen from the above distribution, the majority have their own sources of income, so it appears that they work but they are not registered. Of the remainder, more than 25% of respondents work on a contract or casual basis, almost 4% are self-employed and more than 4% have other sources of income. They mainly work as, for example: office workers (e.g. secretary, clerk) - 9%; service workers (e.g. salesman, tour guide, sales representative) - 6% and 6% work as other professionals (e.g. IT specialist, engineer, doctor, teacher).

## **4. Analysis of the findings**

### **4.1. Analysis and discussion of the findings**

The survey, which was qualitative and quantitative in nature, was conducted in two stages and was divided into six sections.

Stage I (described in detail in (Chmielarz, Zborowski, 2022)):

- information on basic Internet communication tools,
- identification of general knowledge about green energy and its sources,
- review of selected elements of specialized knowledge related to green energy and the conditions for its application now and in the future,
- analysis of the possibilities of using ICT in information and promotion of principles and ideas related to green energy.

Stage II:

- a comparative analysis of the most popular and frequently visited websites and applications related to green energy, from the users' point of view.

The survey included also a section containing demographic data on respondents – including: gender, age, place of residence, education and specialization, professional and financial status.

#### **Stage I – awareness concerning using green energy among respondents**

The first section included infrastructural information introducing the survey topic. To determine the role of ICT in shaping awareness of the need and necessity to replace energy based primarily on "dirty" fuels (coal, oil, gas, etc.), it was necessary to find out how respondents interact with the Internet. The majority (60%) of respondents access green energy portals/applications using a combination of a smartphone and a laptop, followed by

a smartphone alone (28%). This is due to the adopted path of Internet communication development. European countries implemented the first option before the widespread use of smartphones. The distribution of the Internet via smartphones is now a faster and much cheaper strategy. Interestingly, the intermediate option - Internet communication using a tablet - did not prove to be effective (averaging at the level of nearly 4%). The greatest variation measured by Euclidean distance (54%) occurred between Poland and Türkiye, mainly due to the use of a combination of a laptop and a smartphone for Internet communication, as well as using a smartphone exclusively for this purpose. The smallest variation was recorded between Poland and Spain (Euclidean distance of 0.30%), due to cultural similarities and a similar path of ICT development. The next section included questions about respondents' interest in environmental protection. More than 51% of survey participants express an interest in this topic, the largest share (69%) in the PRC. However, some respondents (nearly 30%) are indifferent to the topic, although they have heard of it. The least interested survey participants (38%) were in Poland. The largest differences between the survey results in this regard were between Poland and the PRC (Euclidean distance amounting to 11%), mainly due to the statement *I am interested in it*, despite the generally high value of this option. The relatively smallest differences occurred between the PRC and Spain (Euclidean distance was established at 1.29%). Similar results were obtained in response to the question about interest in replacing 'dirty' energy with 'clean', renewable energy. More than 37% of respondents were interested in such a solution (most in Spain 58%), and 34% were moderately interested in it. The biggest difference in opinions was recorded between Poland and the PRC (Euclidean distance - 16%). Another question was related to where respondents first encountered the term *green energy*. Most of the respondents, 43% on average, had already encountered it at school (most in Poland 55% and in Spain 52%). In second place was the Internet (24% on average), which demonstrates the high position of ICT in disseminating the idea of renewable energy sources (most Poland 28%). In third place was the university (14% on average), with the highest percentage in Türkiye at 23%. The greatest difference (Euclidean distance - 5%) in terms of learning first about green energy was between Poland and Türkiye. To deepen their knowledge on green energy, respondents would mainly look for information on the Internet (21% of respondents on average, the highest number from Poland - 29%). Green literature on the subject came second with 19%, with most respondents choosing this answer in the PRC with 22%. The least attention is paid to colleagues and friends - 6% on average. As a source of information, environmental institutions (15%) and specialized literature (14%) are fairly valued. The largest differences (city distance 40%, Euclidean distance - 4%) occur between Poland and Türkiye, mainly due to the differential use of the Internet in this respect. Among knowledge of green energy sources, respondents' knowledge about hydropower is the highest (26% on average), mainly in Poland 34%, the survey participants know the least about obtaining energy from biogas (5% on average, the highest share - 6%, was recorded in China). Solid biofuels came second (average of 20%) and heat pumps third (average of 13%). In Spain, solar energy (24%) and hydropower and wind

energy (at the level of 18%) were the most widely known to respondents. In fact, the answers of respondents from Türkiye and Spain differed the most (Euclidean distance - 19%), mainly due to the difference in respondents' knowledge about hydropower. The last question to indirectly test respondents' knowledge of the practical applications of green energy solutions was the question about its share in total energy production in each country. Respondents did indeed mostly show a good understanding of this topic. In Poland, more than 70% correctly identified the share of green energy in the total energy production in the country (Produkcja Energii Elektrycznej..., 2022). Unfortunately, respondents from Türkiye and the PRC probably either remembered data from previous years or overestimated the share of energy obtained from water and marked the range (20-30%) almost equally with the correct answer (between 10% and 20%). In these two countries, ranges between 30% and over 50% were marked by Türkiye at 33% and the PRC at 35% respectively. In contrast, there was a significant underestimation in Spain, where only 7% of respondents marked the correct range for the share of green energy (42%). The largest difference was between Poland and Türkiye (Euclidean distance - 31%), with a slightly smaller difference between Poland and Spain (Euclidean distance - 28%). This part of the survey aimed to demonstrate whether respondents were aware of green energy issues and to what extent they were willing to broaden their interests in this area with the help of both electronic and traditional media. Additionally, it was revealed that respondents' perspectives on renewable energy can vary significantly across countries, despite similar economic development and political conditions, including the recent crises.

The following section of the survey aimed to systematize the general knowledge assessed in the previous section's questions and elicit respondents' perspectives on energy-related phenomena, particularly those related to green energy.

Initially, an effort was made to identify a shared definition of green energy among the countries included in the analysis. This was done by searching for "green energy definition" on the internet. Of the five definitions collected in this way: (What Is Green Energy?, 2023; What Is Renewable Energy?, n.d.; Green Energy, 2021; What Is Green Energy?, n.d.), the largest number of respondents (27%) selected the descriptive definition ... *Green energy is only energy obtained from renewable energy sources, such as: sun, wind, water (rivers, tides and sea waves), nuclear energy in a closed fuel cycle (used fuel is recovered unburned fissile materials, reused to produce nuclear fuel), biomass, biogas, bioliquids and biofuels, as well as heat obtained from the ground (geothermal energy), air (aerothermal energy) water (hydrothermal energy) ...* (Energy Source, n.d.). All definitions were equally correct; however, this particular definition was chosen most frequently. It was primarily selected by respondents from Poland and China. The largest discrepancy was observed between Poland and Türkiye, with a Euclidean distance of 13%.

The next question inquired about the definitions mentioned earlier. Four statements were presented that referred to the relationship between clean energy and renewable energy sources. The respondents were asked to select the statement they believed to be the most accurate.



Their choice was largely dependent on the definition they selected earlier, especially that one definition in particular explicitly defined the relationship (*...all renewable energies are green, but not all green energies are renewable...*), thereby influencing the choice of respondents. As a result, the majority of respondents (32%) selected the first statement. Notably, 37% of Polish respondents also agreed with this statement. However, in Türkiye and China, slightly more respondents selected the third statement (*...all green energies are based on renewable and non-renewable sources (distinguished e.g. because of resource limitation or environmental damage)...*), which also corresponds to the broad discussion that takes place around the definition and classification of the term green energy. Overall, there was little variation in the distribution of responses across countries. The largest discrepancy was observed between Poland and Türkiye, with a Euclidean distance of just over 1%. A slightly smaller difference (less than 1% Euclidean distance) was observed between Poland and the PRC.

Next questions included in the survey concerned the advantages and disadvantages of green energy according to respondents' opinions. Among the advantages, undoubtedly the largest number of respondents highlighted the reduction or elimination of greenhouse gases (23% on average, 26% in Poland, 23% in Spain). In the PRC, the largest number of respondents (25%) believe that green energy reduces the risk of depletion of non-renewable resources, ensuring energy security. Ranked third at 18%, survey participants hold the belief that green energy reduces emissions of harmful substances and thus improves the environment as it does not lead to dust emissions. The smallest number of respondents (5% on average) indicated that the use of green energy from an economic point of view creates jobs for installers and manufacturers of green energy equipment and those that handle the disposal of used equipment and materials. There were also reservations about the fact that it reduces the number of jobs in mines, refineries, etc. The responses related to the criterion of optimizing distribution, also allowing the use of local energy sources were largely similar. The greatest variation (Euclidean distance of just over 1%) occurs between the assessments from Poland and the PRC.

In order to evaluate the drawbacks associated with the implementation of green energy technologies, a survey was conducted where respondents were presented with eight options and were asked to identify the most significant disadvantage from amongst them. The results indicated that the highest proportion of respondents (18%) highlighted the high costs associated with investing in renewable energy sources, the need for subsidies and grants from the government (photovoltaic panels, energy storage, etc.); the long payback period (16%), the difficult and underdeveloped ways of disposal (e.g. wind power plants or fissile materials) or the harmful impacts of the production and disposal of some green energy technologies (15%). The biggest differences, due to completely different approaches to green energy in Spain (preference for solar, wind and hydropower), occurred between this country and the other countries (Euclidean distance for PRC-Spain 11%, for Poland-Spain 9% and for Türkiye-Spain 7%). These countries are more dependent on weather conditions (sun, wind) or natural conditions (e.g. rivers with insufficient gradient).

Among widely held opinions, nuclear energy is considered to be green energy because it is decarbonized and does not emit greenhouse gases into the atmosphere. However, it should be taken into consideration that uranium, on which its emission is based, is a costly and limited resource and is dangerous to the environment in the case of an open fuel cycle (used fuel is stored). However, if there were significant investments made into extensive research on nuclear fuels and safe operational and disposal methods, nuclear energy could also be considered clean and renewable. Therefore, respondents were also asked questions about the advantages and disadvantages of atomic energy.

Among the advantages, the highest rating on average (22%), (highest in Poland 27% and the PRC 23%) was given to the lack of emissions of greenhouse gases, dust, sulphur oxides or heavy metals, which improves the health of the population and just behind (21%, highest in Türkiye), the relative safety of new technologies in this respect (compared, for example, to the occurrence of accidents in mines). In Poland, attention was also drawn to the much higher efficiency of obtaining energy from one physical unit of raw material (23%) and independence from weather conditions and high independence from natural conditions (20%), in Türkiye to the lack of noise emissions (compared to e.g. wind power plants), and in Spain to the possibility of using nuclear waste in other areas of the economy e.g. in medicine and the possibility of using the land around nuclear power plants for agricultural purposes (13% each). The largest differences in the Euclidean distance in the responses (8%) were recorded between Poland and Spain.

Statements regarding the drawbacks of nuclear power plants focused on concerns over the possibility of reactor accidents, which pose a threat to life or health of the population (22% on average, highest in Türkiye - 25%), lack of safe methods of nuclear waste disposal (improperly stored may contaminate soil or water) - 18% on average, Poland 23%, and high and increasing costs of nuclear power plant construction - 17% on average, Türkiye 20%. The PRC also singled out technical, competence and construction problems during construction that could increase planned costs (23%), and Spain, similarly to Poland, lack of safe storage methods (16%). The largest, albeit small, difference in Euclidean distance - less than 4% - is between Poland and the PRC.

The previous results indicate that respondents are able to identify green energy, what it can be used for and why it should be used as well as its advantages and disadvantages. The next logical question seemed to be whether they themselves have participated in a green energy project (such as installing a heat pump, photovoltaic panels in the family home, a local hydroelectric plant, a wind turbine, etc.). The highest number of people (41% on average) reported that they have never participated in such a project and do not intend to participate in it in the future. In contrast, slightly fewer respondents (34%) indicated their intention to participate in a green energy venture in the future. Responses related to one-time participation were highest (23%) among respondents from Poland. The largest differences expressed in terms of Euclidean distance were observed between the PRC and Spain (68% of responses) and between Poland and the PRC (58% of responses).

The next question concerned opinions on the future of green energy. Most people (37% on average, most (43%) in the PRC) predicted that green energy would become commonplace in just 10 years. In second place (29% on average) was the answer in 20 years. The most optimistic were respondents from Türkiye (10%), who believe that green energy will be the dominant trend in just one year. The greatest differences in opinion occurred between Poland and Türkiye (Euclidean distance 11%), mainly due to the predominant answer in Poland stating that green energy will be common worldwide *in 20 years*.

The final, but most relevant, section of questions focused on the extent to which ICT can assist in the introduction of green energy, especially in a situation of already somewhat permanent crises. Among the answers given as to how ICT can best help disseminate and implement the idea of green energy, the predominant opinion (19% on average) was related to the role of ICT in informing the public about pollution problems and methods in which we can protect the environment. A similar option – disseminating and popularizing the idea of green energy and informing about its principles – was chosen most frequently (19%) in Türkiye. In Spain, the most common response (18%) was the one focusing on *promoting the online sale of products and services to reduce environmental pollution through dust and greenhouse gas emissions*. In Türkiye, the predominant response (18%) was related to *producing software to monitor pollution and automate pollution reduction*. In the PRC, 19% of respondents chose the option of *intensive marketing of services and products related to green and clean ways of producing energy*. The differences between the statements of respondents from each country were small, i.e. a fraction of a percentage, the largest between Türkiye and Spain not exceeding 0.89% of the Euclidean distance.

The last question included in the section referred to whether the situation of crises (COVID pandemic, threat of armed conflict, energy crisis, internal political crisis, high inflation) influences the drive to promote and implement green energy through ICT and, if yes, how it is being implemented. On average, the largest number of respondents chose the option indicating *moderate influence so as not to upset the economic balance* (38% on average, Poland - 53%, PRC 46%). A similar magnitude was given to the answer indicating that *it could be a way out of the crisis* (average 31%, most Türkiye 39%). The opinion of *no action at all* is less than 2%. The largest differences measured in opinions on this topic occurred between Poland and Türkiye (Euclidean distance of 18%), mainly due to the option stating that ICT should support green energy in *a moderate way*, and the statement that *it can be a way out of the crisis*. A similar situation occurred in the Türkiye-China relationship (Euclidean distance of 12%).

#### **4.2. Comparative analysis of green energy portals/web applications using the scoring method**

In summary, the results of the qualitative analysis so far have shown that the respondents, regardless of the differences between them:

- use infrastructure that allows them to access the Internet on a daily basis,
- have a good understanding of environmental protection issues,
- are aware of the need to implement green energy and would like to have more knowledge about it, mainly obtained on the Internet,
- believe that in a situation of deep crisis, ICT should be allowed to moderately or fully support the idea of green energy and its implementation in a sustainable way because this can be a way out of crises, especially the energy crisis and the related economic crisis.

Following the research procedure, the evaluation by respondents of the most popular, frequently visited, and launched internet services and mobile applications related to green energy in Poland, Türkiye, the PRC, and Spain was then presented. Data for these calculations were collected through the last two survey questions. The first one concerned knowledge of eco-themed services/applications containing references to green energy, and the second one concerned a detailed evaluation according to the adopted rating scale.

Each website/application was rated using a simplified, normalized Likert scale (Likert, 1932), where:

- – meets all user requirements,
- 0.75 – meets most user requirements,
- 0.50 – moderately meets user requirements,
- 0.25 – minimally meets user requirements,
- – does not meet user requirements.

The sum of the average scores obtained was then related to the sum of the maximum scores that could be obtained in the evaluation of the website/application in two cross-sections (for each selected website/application and for each attribute).

A list of 9 to 14 of the most well-known and popular websites/applications was prepared for each country, from which the five most popular among respondents from that country (with over 20 indications) were then selected. The results of the average ratings of the surveyed individuals for the websites/applications, expressed as a percentage of the maximum possible score, are presented in Table 1. The highest ratings were given to the websites/apps in the PRC at 68.86%, 8% higher than the average rating of the countries analyzed. Portals/apps in Türkiye were rated the lowest (meeting only 55.76% of user expectations). The Chinese portal [www.green-stone.org](http://www.green-stone.org) scored highest in the rankings (72.62%), while the Turkish portal [www.tureb.com.tr](http://www.tureb.com.tr) scored worst with 47.40%. The difference between the national averages is 13.10%, between the worst and the best portal/application is 25.22%. Admittedly, these are averaged subjective results, but it is important to indicate that since green energy portals/applications are designed for users, it is only natural that they should be evaluated by them.

**Table 1.**

*The most popular and frequently visited environmental websites/apps in Poland, Türkiye, PRC and Spain*

Country	Link to a website/application	Share in the maximum value
Poland	<a href="http://gramwzielone.pl">http://gramwzielone.pl</a>	52.01%
	<a href="http://zielonagospodarka.pl">http://zielonagospodarka.pl</a>	58.20%
	<a href="http://wysokienapiecie.pl">http://wysokienapiecie.pl</a>	57.74%
	<a href="http://globenergia.pl">http://globenergia.pl</a>	67.52%
	<a href="http://wwf.pl">http://wwf.pl</a>	63.84%
	Average for Polish websites/application	<b>59.86%</b>
Türkiye	<a href="http://www.tureb.com.tr">www.tureb.com.tr</a>	47.40%
	<a href="http://www.zorluenerji.com.tr">www.zorluenerji.com.tr</a>	52.65%
	<a href="http://www.enerjisa.com.tr">www.enerjisa.com.tr</a>	58.63%
	<a href="http://www.kocyigitenerji.com">www.kocyigitenerji.com</a>	59.42%
	<a href="http://www.borusanenbw.com.tr">www.borusanenbw.com.tr</a>	60.71%
	Average for Turkish websites/applications	<b>55.76%</b>
PRC	<a href="http://www.cred.org.net">www.cred.org.net</a>	61.31%
	<a href="http://www.cegreen.org">www.cegreen.org</a>	67.56%
	<a href="http://www.eedu.org.cn">www.eedu.org.cn</a>	70.32%
	<a href="http://www.creia.net">www.creia.net</a>	72.47%
	<a href="http://www.green-stone.org">www.green-stone.org</a>	72.62%
	Average for Chinese websites/applications	<b>68.86%</b>
Spain	<a href="https://www.ree.es/es">https://www.ree.es/es</a>	53.61%
	<a href="https://www.appa.es">https://www.appa.es</a>	56.27%
	<a href="https://www.idae.es">https://www.idae.es</a>	56.58%
	<a href="https://energia.gob.es">https://energia.gob.es</a>	58.93%
	<a href="https://www.cener.com">https://www.cener.com</a>	61.38%
	Average for Spanish websites/applications	<b>57.35%</b>
Average in total		<b>60.46%</b>
Variance		0.50%
Standard deviation		7.06%

Source: own work.

A list of twenty-one attributes has been prepared for evaluating the quality of each website, indicating whether and to what extent a given internet portal/application meets the requirements related to a properly designed and user-friendly website. This is because only such websites are able to attract users and make them return, and the content of the website sometimes plays just as important a role as the way in which it is communicated and the user-friendliness of the website. The list of attributes verified by the respondents is shown in Table 2.

Table 2 shows the results of calculations regarding the shares in the maximum possible score for the average ratings of websites/applications in Poland, Türkiye, the PRC and Spain. The first column lists the attributes according to which the services were evaluated by the respondents, and the following columns show the results for each country and the average.

**Table 2.**

*Results of the comparison of the shares of the maximum possible scores for the average attribute scores of services/applications in Poland, Türkiye, the PRC and Spain*

Attributes/Website/application	Poland % share max. score	Türkiye % share max. score	PRC % share max. score	Spain % share max. score	Average
Automated updates of the application	37.95%	72.50%	66.13%	54.74%	57.83%
Availability of content concerning green energy	75.86%	69.70%	71.88%	57.75%	68.80%
Catalog of cooperating companies, sponsors	56.48%	68.79%	72.50%	53.97%	62.93%
Color scheme	69.12%	66.67%	69.60%	57.84%	65.81%
Comfort	52.85%	68.57%	68.79%	54.70%	61.23%
Convenience of use	63.51%	68.14%	72.17%	57.82%	65.41%
Ease of navigation	74.15%	70.03%	69.70%	57.34%	67.81%
Ease of use of categories related to green energy	66.18%	69.60%	74.54%	57.75%	67.02%
Existence and number of offered products/service categories	40.62%	68.79%	67.47%	56.12%	58.25%
Filtering by national language	50.12%	71.88%	63.82%	58.18%	61.00%
Information on claims and returns	32.78%	67.51%	62.35%	53.31%	53.99%
Informative content on green energy	72.72%	62.35%	67.51%	57.68%	65.06%
Intuitiveness	70.87%	64.52%	68.57%	58.61%	65.64%
Legal aspects regarding the possibility of introducing green energy	64.63%	67.47%	72.63%	60.38%	66.28%
Main menu	71.45%	70.65%	70.03%	58.60%	67.68%
Payment methods for products or services	42.58%	72.63%	67.22%	57.77%	60.05%
Readability of text regarding green energy	74.90%	67.22%	71.07%	59.67%	68.21%
Search for green energy content	71.96%	72.17%	68.14%	57.66%	67.48%
System of ratings and comments on content related to green energy	31.46%	71.07%	70.65%	56.86%	57.51%
User-friendliness	72.15%	63.82%	64.52%	60.28%	65.19%
Visualization	64.73%	66.13%	66.67%	57.43%	63.74%

Source: own work

In Poland, the aspects which were rated highest in the considered websites and applications included: the availability of content regarding green energy (nearly 76%) and the readability of the text describing it (75%). The lowest rating was given to the rating and comments system (31%). In Türkiye, the highest rating (73%) was given to payment methods for or within services (delivery of content), and the lowest rating was given to informative content regarding green energy (62%). In the PRC, the highest rating in these portals/applications was given to the ease of use of the services (75%), the lowest (62%) to information about claims regarding the services provided. In Spain, the legal aspects of the possibility to introduce green energy and the user-friendliness of the website were rated highest (60% each). The lowest rating in the country - 53% was assigned for information about claims or complaints regarding the services provided. The largest spread between the highest and lowest ratings was in Poland (44%), with a 13% spread in the PRC and 11% in Türkiye. On average across the selected countries, the highest ratings were assigned for availability of content regarding green energy (69%), ease of navigation and readability of the text regarding green energy (68%).

The variation in ratings between portals/applications was examined using Euclidean distance. The calculations of Euclidean differences for all attributes are provided in Table 3.

The greatest variation occurred between the attribute ratings of portals/applications in Poland and the other three countries in the following categories:

- in the category of sum of attribute difference coefficients between Poland and Türkiye (40.12%) and Poland and Spain (39, 29%),
- in the category of attribute differences:
- in the case of the attribute rating and comment system of websites/applications in Poland and Türkiye; Euclidean distance (15.69%) and Poland and the PRC; Euclidean distance (15.26%),
- in the case of the attribute of *information about claims concerning services* provided by services/apps from Poland and Türkiye; Euclidean distance (12.06%) and Poland and the PRC; Euclidean distance (8.74%),
- in the case of the *automated update* attribute of services/applications from Poland and Türkiye; Euclidean distance (11.93%) and Poland and the PRC; Euclidean distance (7.94%).

The smallest differences were between Türkiye and the PRC - the sum of Euclidean differences is only 2.22%, and many attribute differences, especially technical attributes such as ease of navigation, main menu appearance, user-friendliness, comfort, rating and comment system and visualization take zero value.

**Table 3.**

*Differences between average ratings of attributes of green energy websites/applications*

Differences between countries/attribute	Poland-Türkiye	Poland - PRC	Türkiye-PRC	Poland-Spain	Türkiye-Spain	PRC-Spain	Average
Legal aspects regarding the possibility of introducing green energy	0.08%	0.64%	0.27%	0.18%	0.50%	1.50%	0.53%
Automated updates of the application	11.93%	7.94%	0.41%	2.82%	3.15%	1.30%	4.59%
Availability of content regarding green energy	0.38%	0.16%	0.05%	3.28%	1.43%	2.00%	1.22%
Filtering by national language	4.73%	1.88%	0.65%	0.65%	1.88%	0.32%	1.68%
Information on claims and returns	12.06%	8.74%	0.27%	4.21%	2.02%	0.82%	4.69%
Informative content on green energy	1.08%	0.27%	0.27%	2.26%	0.22%	0.97%	0.84%
Intuitiveness	0.40%	0.05%	0.16%	1.50%	0.35%	0.99%	0.58%
Existence and number of offered product/service categories	7.94%	7.21%	0.02%	2.40%	1.61%	1.29%	3.41%
Catalog of cooperating companies, sponsors	1.52%	2.57%	0.14%	0.06%	2.20%	3.44%	1.65%
Color scheme	0.06%	0.00%	0.09%	1.27%	0.78%	1.38%	0.60%
Comfort	2.47%	2.54%	0.00%	0.03%	1.92%	1.99%	1.49%

Cont. table 3.

Ease of use of categories related to green energy	0.12%	0.70%	0.24%	0.71%	1.40%	2.82%	1.00%
Ease of navigation	0.17%	0.20%	0.00%	2.83%	1.61%	1.53%	1.06%
Main menu	0.01%	0.02%	0.00%	1.65%	1.45%	1.31%	0.74%
User-friendliness	0.69%	0.58%	0.00%	1.41%	0.13%	0.18%	0.50%
Methods of payment for products or services	9.03%	6.07%	0.29%	2.31%	2.21%	0.89%	3.47%
System of ratings and comments on content related to green energy	15.69%	15.36%	0.00%	6.45%	2.02%	1.90%	6.90%
Visualization	0.02%	0.04%	0.00%	0.53%	0.76%	0.85%	0.37%
Convenience of use	0.21%	0.75%	0.16%	0.32%	1.06%	2.06%	0.76%
Search for green energy content	0.00%	0.15%	0.16%	2.05%	2.11%	1.10%	0.93%
Readability of text regarding green energy	0.59%	0.15%	0.15%	2.32%	0.57%	1.30%	0.85%
Total	40.12%	29.46%	2.22%	39.26%	29.37%	29.92%	28.39%
Variance	0.24%	0.17%	0.0003%	0.02%	0.01%	0.01%	
Standard deviation	4.92%	4.08%	0.17%	1.56%	0.80%	0.76%	
F-Snedecor Test	27.28	22.58	0.83	61.97	2.27	2.75	

Source: own work based on the survey results.

In addition, it was hypothesized that there was a significant average variation in services/applications between the countries analyzed according to a distinguished set of their characteristics (attributes). The differentiation was examined using the right-sided Fisher-Snedecor test  $(20,3)$ . The obtained values for comparing the differentiation between: Poland and Türkiye (27.28), Poland and the PRC (22.58) and Poland and Spain (61.97), for a significance level of 0.05; respectively, are above the cut-off level of 8.66, so the  $H_0$  hypothesis for these three differences was confirmed. However, it was not confirmed for the differences between Türkiye and the PRC (0.83), Türkiye and Spain (2.27) and PRC and Spain (2.75).

#### 4.3. Quantitative analysis using the conversion method

The multi-criteria conversion method was developed for the evaluation of websites in order to make the collection of data from the average user as easy as possible (data are collected using the scoring method), while at the same time bringing the subjective results of the scoring method closer to reality by relating the results of the scoring analysis to the averages in the individual categories (attributes). A brief description of the method is presented below (Chmielarz, Zborowski, 2013).

This method consists in determining the relation of each criterion to other criteria, based on averaged distances from the maximum potential value established on the basis of previous scoring evaluation. Data received from scoring evaluation is the starting point for a conversion method. The steps of the conversion method are as follow.

- I. Established preference vector of the superior level criteria (first converter) constructing a matrix of distances from the maximum value for each criterion in every website, establishing the maximum value:



$$P_{i,max} = \text{Max}\{f_i(a_j), \dots, f_n(a_m)\} \text{ for } i = 1, \dots, n \text{ and } j = 1, \dots, m \quad (1)$$

1. establishing the matrix of the distances from the maximum value

$$\delta(f_i(a_j)) = P_{i,max} - f_i(a_j) \text{ for } i = 1, \dots, n \text{ and } j = 1, \dots, m \quad (2)$$

2. calculating the average distance from the maximum value for each criterion,

$$\overline{F}_{i,j} = \frac{\sum_{j=1}^m \delta(f_i(a_j))}{m} \quad (3)$$

3. as a result of the above operation, constructing a matrix of differences in the distance from the maximum value and the average distance according to criteria,
4. for each website: constructing conversion matrices - modules of relative distances of particular criteria to remaining criteria (the distance from the same criterion is 0), the obtained distances below the diagonal are the converse of the values over the diagonal,
5. averaging criteria conversion matrices – creating one matrix of average modules of values for all criteria:

$$\overline{A}_{i,j} = \frac{\sum_{i=1, j=1}^{n,m} (\alpha_{i,j} - \alpha_{i+2,j})}{n} \quad (4)$$

6. transforming the conversion matrix of criteria into a superior preference matrix (calculating squared matrix, adding up rows, standardization of the obtained preference vector; repeated squaring, adding up rows, standardization of preference vector – repeating this iteration until there are minimum differences in subsequent preference vectors).

II. As a result of the above operations we establish a criteria conversion matrix  $Ta_{mx1}$ . Subsequently, the authors performed a transformation of the scores presented by experts on the level of a matrix specifying expert websites' evaluations for particular criteria (second converter). The results have been obtained in an analogical way:

1. constructing a matrix of distances from the maximum value for each criterion and each website:

- a. establishing the maximum value

$$P_{i,max} = \text{Max}\{f_i(a_j), \dots, f_n(a_m)\} \quad (5)$$

for  $i = 1, \dots, n$  and  $j = 1, \dots, m$

- b. establishing the matrix of distances from the maximum value

$$\delta(f_i(a_j)) = P_{i,max} - f_i(a_j) \text{ for } i = 1, \dots, n \text{ and } j = 1, \dots, m \quad (6)$$

2. calculating the average distance from the maximum value for each website,

$$\overline{F}_i = \frac{\sum_{j=1}^m \delta(f_i(a_j))}{m} \quad (7)$$

3. constructing a matrix of the differences of deviations from the maximum value and the average distance of the features from the maximum,
4. for each criterion: constructing a matrix of transformations (conversions) of the differences of the average distance from the maximum value between the websites, analogically as presented above values below the diagonal are the converse of the values over the diagonal,
5. constructing a module matrix of transformations of the differences of average distance from the maximum value between the websites, for each criterion,

$$\bar{A}_{i,j} = \frac{\sum_{i=1,j=1}^{n,m} (\alpha_{i,j} - \alpha_{i+2,j})}{n} \quad (8)$$

6. for each module matrix of transformation of the differences of the average distance from the maximum value between the websites, squaring it, adding up rows, standardization of the obtained ranking vector and repeating this operation until the obtained differences between two ranking vectors for each criterion will be minimal,
7. As a result of the above presented operations we obtain a conversion matrix of websites' evaluations:  $Tf_{m \times 1}$ 
  - a. using the obtained vectors to construct a combined ranking matrix – returning to the matrix where in
  - b. its side-heading there are criteria, in the heading names of bank websites by appropriate transfer of the obtained preference vectors for each criterion,
  - c. multiplying the matrix obtained in such a way by the previously calculated preference vector,

$$T' = Tf \otimes Ta \quad (10)$$

- d. analysing final results and drawing conclusions note: the lowest distances in this case are the most favourable, comparability adjustments to other methods can be obtained by subtracting these values from 1 and their repeated standardization (details of the method see: (Chmielarz, Zborowski, 2013)),

In the case analyzed for Poland, Türkiye, the PRC and Spain, data on green energy portals/applications were collected by means of an online survey. Its results for average ratings were previously described using the scoring method. The same input data set was also used in the calculations in the conversion method.

In the course of data collection, this method is much more convenient for users as it allows them to answer survey questions in a more "user-friendly and comprehensible way than, for example, the ELECTRA or PROMETTEE methods, the TOPSIS method (giving similar results), and certainly than the AHP/ANP method" (Saaty, 2008). As shown in the previous

section, it also allows for an easy and broad interpretation of the results also in regional analyses. The subjectivity of respondents is reduced in direct proportion to the number of respondents, although it appears to be no greater than when comparing pairs of mismatched attributes in the AHP method. However, in the conversion method based on distances from the mean results in each category, the computational burden, as with other methods, is transferred to the software. The obtained results, similar to the AHP method, have a lower correlation coefficient  $R^2$  than other multicriteria methods. Due to the adopted calculation algorithm, the results obtained also differ from those of scoring methods and their interpretation is more difficult and less obvious than in scoring methods.

Table 4 shows a cross-section of the average ratings of the characteristics of the examined portals in each country. It can be seen that different attributes are valued most highly in each of them. In Poland, it is the catalogue of cooperating companies and sponsors (14.37%), understood as forms that directly or indirectly support the idea of green energy, and the existence and number of offered product/service categories in the field of environmental protection (8.80%). In Türkiye, it is a system of ratings and comments on content related to green energy (9.99%) and for technical reasons - user-friendliness of the site for the user (11.40%). In the PRC, the best-rated features are: ease of use of categories related to green energy (7.90%) and the ability to filter by national language (8.16%). In Spain, the country with the most developed and used green energy technology, the issue is so well known that attention is mainly paid to the ability to filter by national language (7.87%) and the ease of site navigation (7.27%). Nevertheless, Spanish portals/applications are still rated highest by users. Above the average rating in Spain, there are 10 features out of 21, in the PRC - 7, in Poland - 8 and Türkiye - 9. On average, the lowest rated features are ease of use of categories related to green energy (1.28%) and the appearance of the Main menu (1.41%) and information on claims and returns (1.42%).

**Table 4.**

*Average scores for the attributes of the portals/applications in the surveyed countries according to the conversion method and an assessment of their Euclidean distance*

Measure/Country/Attribute	The average for each country			
	Poland	Türkiye	PRC	Spain
Legal aspects regarding the possibility of introducing green energy	4.49%	2.71%	2.81%	2.64%
Automated updates of the application	5.63%	4.51%	6.58%	6.01%
Availability of content regarding green energy	5.60%	3.67%	3.08%	3.78%
Filtering by national language	3.64%	4.28%	8.16%	7.87%
Information on claims and returns	1.68%	4.00%	4.62%	3.48%
Informative content on green energy	4.72%	7.72%	4.75%	4.16%
Intuitiveness	5.22%	4.20%	2.99%	6.30%
Existence and number of offered product/service categories	8.80%	3.57%	5.55%	4.69%
Catalog of cooperating companies, sponsors	14.37%	3.88%	4.01%	3.56%
Color scheme	4.49%	5.48%	4.34%	5.82%
Comfort	4.24%	4.00%	6.84%	3.32%
Ease of use of categories related to green energy	2.50%	2.64%	7.90%	6.32%

Cont. table 4.

Ease of navigation	2.82%	4.90%	3.04%	7.27%
Main menu	3.62%	2.00%	2.56%	2.45%
User-friendliness	4.46%	11.40%	4.38%	4.03%
Methods of payment for products or services	3.99%	3.00%	6.23%	4.96%
System of ratings and comments on content related to green energy	1.92%	9.66%	6.00%	6.52%
Visualization	5.42%	4.03%	3.71%	3.06%
Convenience of use	2.88%	5.03%	3.94%	4.48%
Search for green energy content	5.94%	5.54%	4.66%	5.78%
Readability of text regarding green energy	3.59%	3.78%	3.85%	3.51%
Standard deviation	2.71%	2.28%	1.65%	1.57%
Variance	0.07%	0.05%	0.03%	0.02%

Source: own work based on the survey results.

The differences measured by Euclidean distances between the responses of respondents from the countries analyzed are highest between Türkiye and Spain (5.80%), mainly due to the perception of the user-friendliness of the website (1.30%) and the quality of the system of ratings and comments on content related to green energy (0.93%). The differences between Poland and Türkiye are almost halved (2.85%), which was caused mainly by the catalogue of cooperating companies and sponsors (1.10%), and the system of ratings and comments on content related to green energy (0.60%). The results are presented in Table 5.

**Table 5.**

*Evaluation of the Euclidean distance between the mean scores of the attributes of the portals/applications in the analyzed countries*

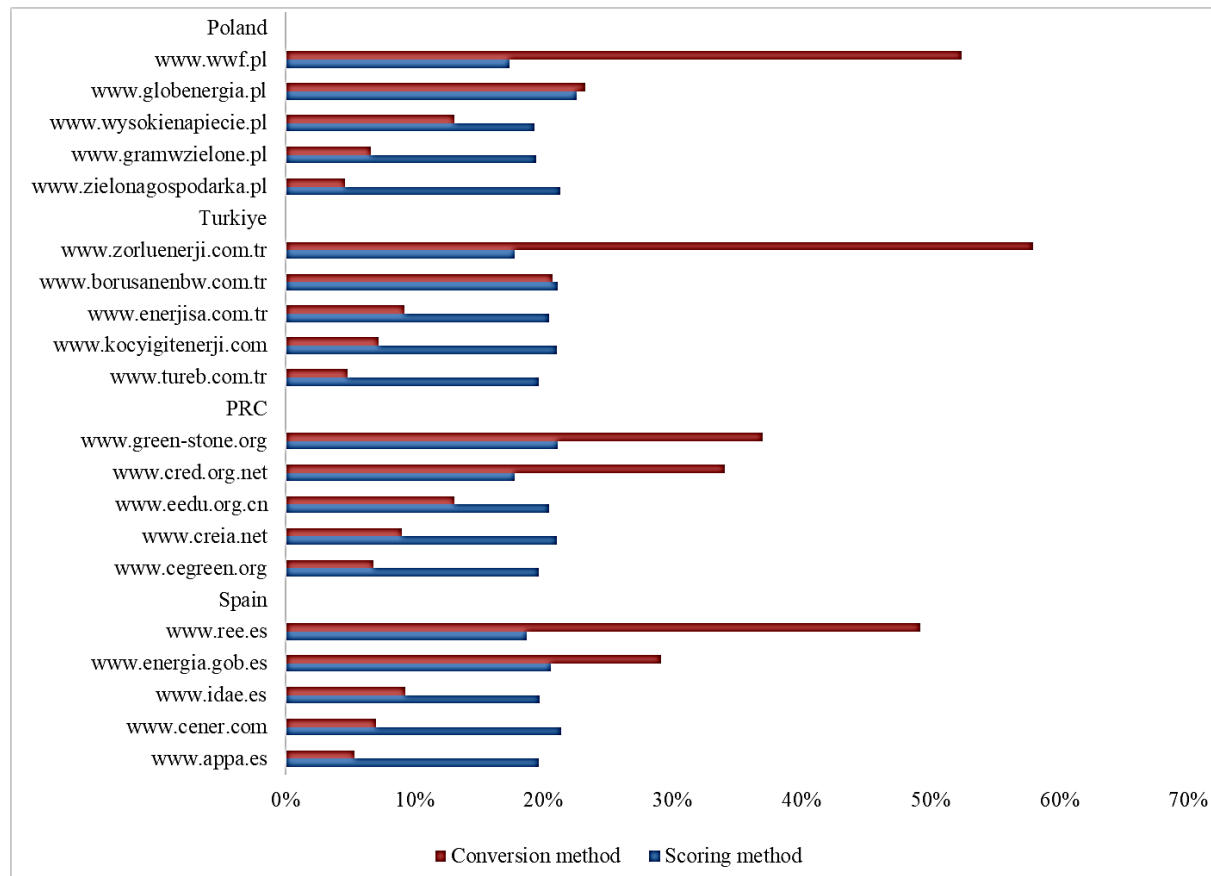
Measure/Country/Attribute	Euclidean distance					
	Poland-Türkiye	Poland-PRC	Poland-Spain	Türkiye - PRC	Türkiye-Spain	PRC-Spain
Legal aspects regarding the possibility of introducing green energy	0.0317%	0.0283%	0.0001%	0.0082%	0.0732%	0.0003%
Automated updates of the application	0.0124%	0.0092%	0.0429%	0.0392%	0.2038%	0.0033%
Availability of content regarding green energy	0.0371%	0.0637%	0.0036%	0.0184%	0.1350%	0.0049%
Filtering by national language	0.0041%	0.2042%	0.1506%	0.0528%	0.1830%	0.0008%
Information on claims and returns	0.0541%	0.0866%	0.0038%	0.0667%	0.1602%	0.0130%
Informative content on green energy	0.0901%	0.0000%	0.0885%	0.2125%	0.5959%	0.0034%
Intuitiveness	0.0105%	0.0498%	0.0145%	0.0340%	0.1763%	0.1093%
Existence and number of offered product/service categories	0.2731%	0.1055%	0.0391%	0.0023%	0.1276%	0.0075%
Catalog of cooperating companies, sponsors	1.1001%	1.0715%	0.0002%	0.0047%	0.1503%	0.0021%
Color scheme	0.0098%	0.0002%	0.0128%	0.0891%	0.2999%	0.0218%
Comfort	0.0006%	0.0678%	0.0808%	0.0376%	0.1598%	0.1242%
Ease of use of categories related to green energy	0.0002%	0.2915%	0.2767%	0.0183%	0.0697%	0.0250%
Ease of navigation	0.0435%	0.0005%	0.0347%	0.0884%	0.2404%	0.1787%
Main menu	0.0263%	0.0112%	0.0032%	0.0035%	0.0399%	0.0001%
User-friendliness	0.4818%	0.0001%	0.4925%	0.5530%	1.3000%	0.0012%
Methods of payment for products or services	0.0098%	0.0498%	0.1040%	0.0157%	0.0901%	0.0161%

Cont. table 5.

System of ratings and comments on content related to green energy	0.5989%	0.1663%	0.1340%	0.4577%	0.9335%	0.0027%
Visualization	0.0192%	0.0292%	0.0011%	0.0279%	0.1626%	0.0042%
Convenience of use	0.0464%	0.0113%	0.0119%	0.0932%	0.2530%	0.0030%
Search for green energy content	0.0016%	0.0163%	0.0077%	0.0711%	0.3064%	0.0125%
Readability of text regarding green energy	0.0004%	0.0007%	0.0001%	0.0375%	0.1428%	0.0012%
Total	2.85%	2.26%	1.50%	1.93%	5.80%	0.54%
Standard deviation	0.27%	0.23%	0.12%	0.15%	0.31%	0.05%
Variance	0.00075%	0.00055%	0.00014%	0.00021%	0.00095%	0.00002%

Source: own work based on the survey results.

In general, there were also differences in the rankings determined by the conversion method and the scoring method, irrespective of the country involved (Figure 1). These mainly consist of a greater spread between the highest and lowest scores and a change in the order of the rankings.



**Figure 1.** Assessment of the quality of services and applications using the conversion method and the scoring method.

Source: own work.

The difference concerning specific places in rankings was the highest among the portals/applications analyzed in Poland (10 points) and the lowest in PRC (6 points). In terms of Euclidean distance, the largest difference (16%) occurred in the evaluation of the Turkish portal [www.zorluenerji.com.tr](http://www.zorluenerji.com.tr), and the smallest (0.001%) in the case of the Turkish portal [www.borusanenbw.com.tr](http://www.borusanenbw.com.tr). Similar differences occurred in Polish portals - the largest

Euclidean difference (12%) in the evaluation of [www.wwf.pl](http://www.wwf.pl), and the smallest (0.005%) in the evaluation of [www.globenergia.pl](http://www.globenergia.pl). The smallest variation in Euclidean scores obtained using both methods, just over 2%, is found in the assessment of Chinese portals/applications, a slightly larger 8.5% of Spanish portals/applications.

The differences in rankings according to the scoring method and the conversion method between the average attribute scores were greatest (19 items) for the user-friendliness of the website, and the methods of payment for products/services, automatic application updates and information about complaints and returns (12 items each). No difference occurred in the case of the search for green energy content and filtering by national language.

The conversion method is currently being tested for the banking sphere, in order to compare it with other multi-criteria methods and to modify the method in order to reduce the differences between the lowest and highest scores.

## 5. Conclusions

The conducted research justifies drawing the conclusions presented below.

Stage I was an introductory study on green energy awareness and the basis for conducting comparative research on the most popular and frequently visited websites related to this topic.

Stage I:

- respondents in all analyzed countries use information technology infrastructure on a daily basis to communicate with the Internet (mainly smartphones: the PRC, Türkiye), PCs, and smartphones (Poland, Spain);
- the majority (on average 53%) of the surveyed people are very familiar with and well-versed in issues related to green energy, and they have learned about it in school,
- respondents have the greatest knowledge about wind, solar, and water energy,
- the surveyed people are aware of the need to implement green energy, which is mainly expanded through knowledge obtained from the Internet; hence, the role of ICT in promoting green energy topic,
- websites and internet applications are perceived as the primary tools for propagating green energy,
- despite concerns about the lack of complete protection against disasters, nuclear energy is seen as a temporary alternative to green energy,
- the survey participants agreed on the role of ICT related to such activities as informing society about environmental pollution problems and methods of environmental protection, promoting green energy ideas and informing about its principles, and developing software for monitoring pollution and automating the reduction of its level,

- differences between responses obtained from the analyzed countries were not so significantly despite existing cultural and economic differences, although the greatest differences occurred mainly between Poland and the other countries.

#### Stage II:

The second stage involved the evaluation and comparative analysis of green energy services in the surveyed countries. The analysis was conducted for each country individually and by comparing the results from the selected countries. The analysis was carried out using two methods: a simple scoring method and a conversion method. Rankings were obtained for each country and across the evaluation of the attributes of the portals analyzed in the study.

Analyses are most commonly used for:

- determining the order of popularity of portals/applications in order to propagate the content analyzed in this study,
- assessing which criteria influence this popularity and to what extent,
- comparing portals/applications between countries in order to establish basic principles of cooperation between them, especially if they are culturally distant or currently at a different economic level,
- creating a template (pattern), as a guideline for analysts of the selected issue and designers of portals/web applications (a template to follow, material for pre-design analyses, for establishing functionality and HCI (Human-Computer-Interaction) techniques and for comparing methods used to evaluate modern ICT tools).

Given the results obtained, they can be used to:

- identify the top-rated portals and thus encourage visits to them,
- identify the characteristic features and content that are best developed on individual portals, which will ensure their popularity,
- provide guidance on what to pay attention to when addressing portals/applications related to environmental and green energy content in global markets,
- show which multicriteria evaluation methods can be used to solve problems with data collection and processing, especially in the field of green energy, in a rational way,
- create a mapping of the best-rated attributes found in the most popular portals/applications in a given country and internationally, and then use it as a basis for designing a new, competitive portal/application against existing ones.

An example of how to proceed is presented below based on information concerning selected portals/applications operating in Poland. The results obtained as a result of the study for individual attributes of the most popular portals/applications in Poland are shown in Table 6. All attributes whose value exceeds the average are marked with the letter G (Good), those whose results were the highest - with the letter B (the Best), results below the average with the letter - P (Poor), and the worst - W (the Worst).

**Table 6.**

*Mapping of average results of evaluation of attributes of the most popular portals/ applications in Poland*

<b>Poland</b>	<b>gramwzielone.pl</b>	<b>zielonagospodarka</b>	<b>wysokienapiecie.pl</b>	<b>globenergia.pl</b>	<b>wwf.pl</b>
Legal aspects regarding the possibility of introducing green energy	W	B	G	P	G
Automated updates of the application	B	P	P	P	W
Availability of content regarding green energy	G	B	W	P	P
Filtering by national language	W	G	G	P	B
Information on claims and returns	P	W	P	P	B
Informative content on green energy	W	P	B	P	P
Intuitiveness	B	G	W	G	P
Existence and number of offered product/service categories	G	B	P	W	P
Catalog of cooperating companies, sponsors	G	B	P	P	W
Colour scheme	P	W	B	P	P
Convenience	W	P	B	G	P
Ease of use of categories related to green energy	W	P	P	B	G
Ease of navigation	G	P	W	P	B
Main menu	W	P	G	B	G
User-friendliness	G	W	P	P	B
Methods of payment for products or services	W	P	B	G	G
System of ratings and comments on content related to green energy	P	P	W	P	B
Visualization	B	G	P	W	G
Convenience of use	P	W	P	B	G
Search for green energy content	P	W	B	P	P
Readability of text regarding green energy	W	P	P	B	P

Source: own work based on survey results.



With the above table, the portal/application designers can adopt the following procedures: in Table 6, obtained by the conversion method, take the highest values in each row (B) and analyze the reasons why they were considered the best by the respondents. On this basis, build a new portal/application, taking into account only the best results and using them as a model. If they wish to obtain even better knowledge then they should:

- check the average ratings among the respondents for the attributes to determine to what extent they fulfill their requirements (based on the scoring analysis),
- then it is necessary to familiarize themselves with the worst (W) characteristic features of individual portals and determine what can be improved in them, not just by modeling them on those that were defined as the best ratings (B). Of course, they can try to build a portal/application based on the principle that only those attributes that received the worst ratings in the rows are improved, but it appears to be a more challenging path than using the best ones as models,
- another approach could be to improve all "good" but not the best-rated attributes marked with the letter (G) and bring them up to the level of the best (W).

Naturally, this is just one of the possible directions for using the obtained results in the process of improving the design of web portals/applications. Nevertheless, in addition to typical applications, it can be helpful in project management.

The research encountered limitations that may affect the results and their generalizability:

- comparisons and analyses were conducted for four selected countries: Poland, Türkiye, the PRC, and Spain,
- a survey was conducted to obtain data mainly in academic environments, among online shoppers who are the most active Internet users, but with limitations regarding age groups and financial resources (Batorski, 2015). Surveys conducted outside of the university were also filled out primarily by young people who use the Internet on a daily basis and generally have a positive attitude towards environmental protection,
- the impact of selected attributes was analyzed only for the five most popular green energy websites and applications indicated by respondents in the analyzed countries.

The above-mentioned limitations can be minimized in future studies by:

- expanding the number of analyzed countries to include, for example, North or South American countries, or African countries,
- collecting data involving a research sample outside of the academic environment while still maintaining the database on university servers for security reasons,
- analyzing the ratings of attributes for websites and internet applications related to green energy in the analyzed countries using various multicriteria methods to obtain results that allow for more unambiguous decisions.

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## ROLE OF MOTIVATION IN DEVELOPING A PRO-INNOVATION ORGANIZATIONAL CULTURE

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**Purpose:** The aim of the research is to develop a set of good motivational practices for the development of an organization's pro-innovation culture.

**Design/methodology/approach:** A bibliometric analysis and an analysis of publications on such topics as motivation and related methods, techniques and tools, organizational culture, and innovation and pro-innovation culture were conducted. In order to understand the factors shaping innovation culture, it was necessary to interview executives – in particular, the leaders of innovation projects implemented in the Opolskie Voivodeship. The research made it possible to draw conclusions, to identify some good practices and, most importantly, it provided a rationale for conducting more extensive research in which motivation is one of the key factors in the development of an enterprise's innovation potential (along with the leadership function, cooperation with the environment of the enterprise, trust, etc.).

**Research limitations/implications:** The main limitations are the number of interviewed individuals and the focus on a single factor shaping a pro-innovation culture in an organization – motivation.

**Practical implications:** The research resulted in a set of guidelines for creating a pro-innovation culture in an organization. It can serve as a journal of good practices, especially for less experienced leaders.

**Originality/value:** The main contribution of the article is the opportunity to learn the opinion of managers/leaders on the effectiveness of using selected methods and tools to build a pro-innovation culture in an organization.

**Keywords:** innovations, motivation, pro-innovation culture, innovation-oriented culture.

**Category of the paper:** research paper.

## 1. Introduction

Motivation is a powerful factor that has a considerable impact on the functioning of companies. However, deciding which tools are effective and which methods to select is not an easy task. These decisions require experience, knowledge, and intuition. Numerous studies have been carried out to uncover the complexity of this phenomenon, particularly in terms of intrinsic and extrinsic motivation, tangible and intangible motivation, and, finally, the role of motivation in management functions. However, an analysis of related literature indicates that there is a need for further research in the field of motivation for the development of an organization's pro-innovation culture. This is a research gap.

If companies want to withstand intense competition, increasing consumer demands, and, finally, the changing environment, they must develop the creativity of their employees and invest in innovative activities.

This article is an attempt to systematize knowledge on pro-innovation culture and the tools of motivation that shape it. The research conducted is aimed at developing a set of good practices in the field of motivation for the development of an organization's pro-innovation culture. This research is a prelude to a more extensive study. In the subsequent stage, it will be supplemented by observations made in individual organizations. This will make it possible to examine other factors shaping the innovative potential of an enterprise, for example: the leadership function, cooperation with the enterprise environment, or trust.

The article is structured into five main sections: a bibliometric analysis, which assesses the current literature; a theoretical background, which provides the theoretical framework of the research; a description of the methodology, which details the research approach; the results – a presentation of the empirical findings; and conclusions summarizing the key outcomes and implications.

## 2. Bibliometric analysis

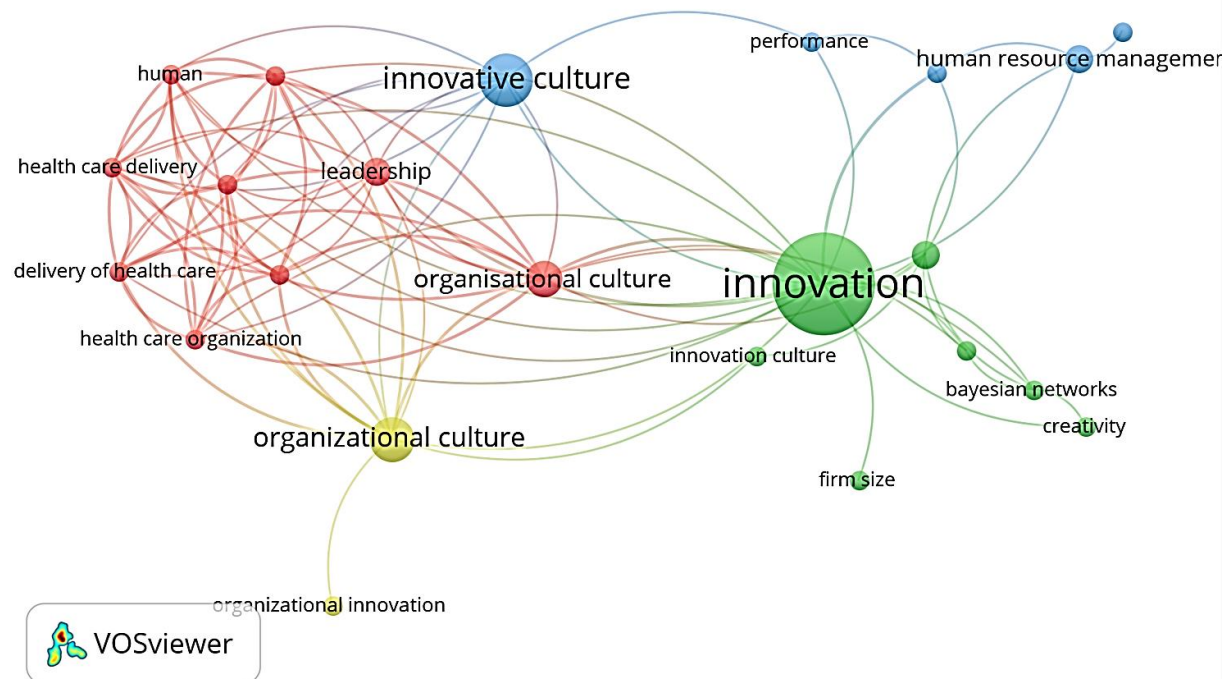
In the last quarter of 2023, an analysis of scientific publications was conducted using the Scopus database. Publications with the keyword “innovation culture” were searched. The results were limited to English-language articles in the field of “Business, Management and Accounting,” yielding 55 publications. After limiting the results to the most up-to-date research, i.e., from 2020 to 2023, a database of 35 publications was obtained.



The Scopus database was also queried with keywords such as “proinnovative culture,” “innovation-oriented culture,” and “innovative organization culture.” Ultimately, due to the number of publications searched, it was decided to download the database for “innovative culture.”

The database sourced from Scopus included keywords and abstracts of publications. The results are shown in Figure 1 and Table 1. Figure 2 illustrates the relationships between “innovative culture” and other keywords. Four main research areas (thematic clusters) were identified and color-coded in Figure 1: healthcare (red), human resource management (blue), innovation and creativity (green), and organizational culture (yellow).

Table 1 shows the keywords along with their total strength of association (an indicator of the strength of associations between keywords). The table also contains “occurrences”, which represents the number of times a specific keyword appears in the retrieved database. The main keywords are “Organizational culture” (total link strength: 25) and “Innovation” (total link strength: 24).



**Figure 1.** Results for innovative culture (VOSviewer).

**Table 1.**

*Results for innovative culture (VOSviewer)*

Cluster	Keyword	Occ	Tot	Cluster	Keyword	Occ	Tot
<b>Healthcare</b>	Delivery of healthcare	2	21	<b>Innovation and creativity</b>	Bayesian networks	2	5
<b>Red cluster</b>	Healthcare delivery	2	21	<b>Green cluster</b>	Creativity	2	2
	Healthcare facility	2	21		Firm size	2	1
	Healthcare organization	2	21		Innovation	12	24

Cont. table 1.

	<b>Health facilities</b>	<b>2</b>	<b>21</b>		<b>Innovation culture</b>	<b>2</b>	<b>2</b>
	Leadership	3	13		Innovative culture	3	8
					Transformational leadership	2	4
<b>Human resource management</b>	Developing countries	2	1	<b>Organizational culture</b>	Organizational culture	4	25
<b>Blue cluster</b>	Human resource management	3	4	<b>Yellow cluster</b>	Organizational innovation	2	1
	Industrial performance	2	5				
	Innovation culture	2	2				
	Performance	2	3				

Occ – Occurrences; Tot – Total link strength.

The authors examine enterprises belonging to different industries or focus on one, such as: healthcare organizations (Andersson, 2022), agribusiness (Kusnandar et al., 2023), banking (Govender, Maralack, 2022), the hotel industry (Sarhan et al., 2020), transportation (Sadiq et al., 2023), or the tourism industry (Hermawat et al., 2022). The publications also cover issues related to the public sector (Ashok, 2021; Dzvinchuk et al., 2021), or the SME sector (Hermawat et al., 2022; Kusnandar et al., 2023; Makanyeza et al., 2023; Ngo, 2022).

The analyzed socio-economic issues are related to: the digital transformation era (Troise et al., 2022), sustainability (Nabi et al., 2023; Sadiq et al., 2023), and the role of developing countries (Makanyeza et al., 2023; Ngo, 2022; Sadiq et al., 2023). Current trends such as ESG reporting are analyzed (Minsuck, Boyoung, 2022).

The authors focus on research problems in the following areas: knowledge-sharing (Ayestarán et al., 2022) and knowledge management (Arokiasamy et al., 2021). The problem of innovative culture is also analyzed from the perspective of HRM, for example: innovative culture of personnel management (Klipkova et al., 2022). Determinants of innovative culture are taken into account, such as: leadership (Hakim et al., 2023; Nabi et al., 2023), interorganizational links (Wipulanusat et al., 2020; Zhao et al., 2023), or trust (Krot, Lewicka, 2020).

Publications were then searched including the two keywords “innovation culture” and “motivation”. The results were limited to English-language articles in the field of “Business, Management and Accounting” from the period 2020 to 2023. In this manner, only two publications were acquired in the following areas: intrapreneurial leadership in education context (Hakim et al., 2023) and success factors in project (Santos-Vijande et al., 2021). It can be concluded that the number of publications retrieved as well as their content indicate the need for further research in the field of motivation for the development of an organization's pro-innovation culture – this is a research gap.

### 3. Theoretical background

The terms “proinnovative culture” (Lewicka, 2012), “innovation-oriented culture” (Bienkowska, 2013), “innovative organization culture” (Jin, Kim, 2022), and “culture of innovation” (Hermawat et al., 2022) refer to “the role of the organizational culture in the development of the ability of the organization to act innovatively” (Bienkowska, 2013). In view of the above, we understand pro-innovation culture as a system of values, norms, and practices that promote creativity, experimentation, and the implementation of new solutions in the organization. It is a set of beliefs and attitudes that make employees more willing to take risks and think outside the box.

To create an innovation-friendly environment, it is necessary, among other things, to (Jagoda-Sobalak, Lapuńska, 2018):

- foster a culture of learning and development – people who are open to new ideas are more likely to create innovations,
- give employees freedom and autonomy – people are more creative when they have freedom of action,
- build bonds and create an atmosphere of cooperation and exchange of information – innovations often arise from interactions between people representing different fields,
- create an incentive system focused on innovation, and
- give people resources and support.

Innovation is the key to success in today's world. Companies that are able to create innovations are more competitive and more likely to succeed. Innovations also matter to society because they can improve our lives in many areas, such as health, education, and the environment. Building creative teams is essential in developing a culture of innovation. A creative atmosphere is based on three pillars: personal creativity, team creativity, and organizational creativity. Each of the components should be developed through a creative management style and an incentive system that promotes creative attitudes (Czerwinska-Lubszczyk, Grebsli et al., 2022).

Innovations require not only creativity but also resolve. It is especially incumbent on leaders and managers to develop the creativity of employees. In the literature, we can find numerous tips for developing a creative work environment. Leaders should first and foremost foster the following attitudes (Chodkowski, 2019; Czerwińska-Lubszczyk, Grebsli et al., 2022; Prońko, Wojtasiak, 2016):

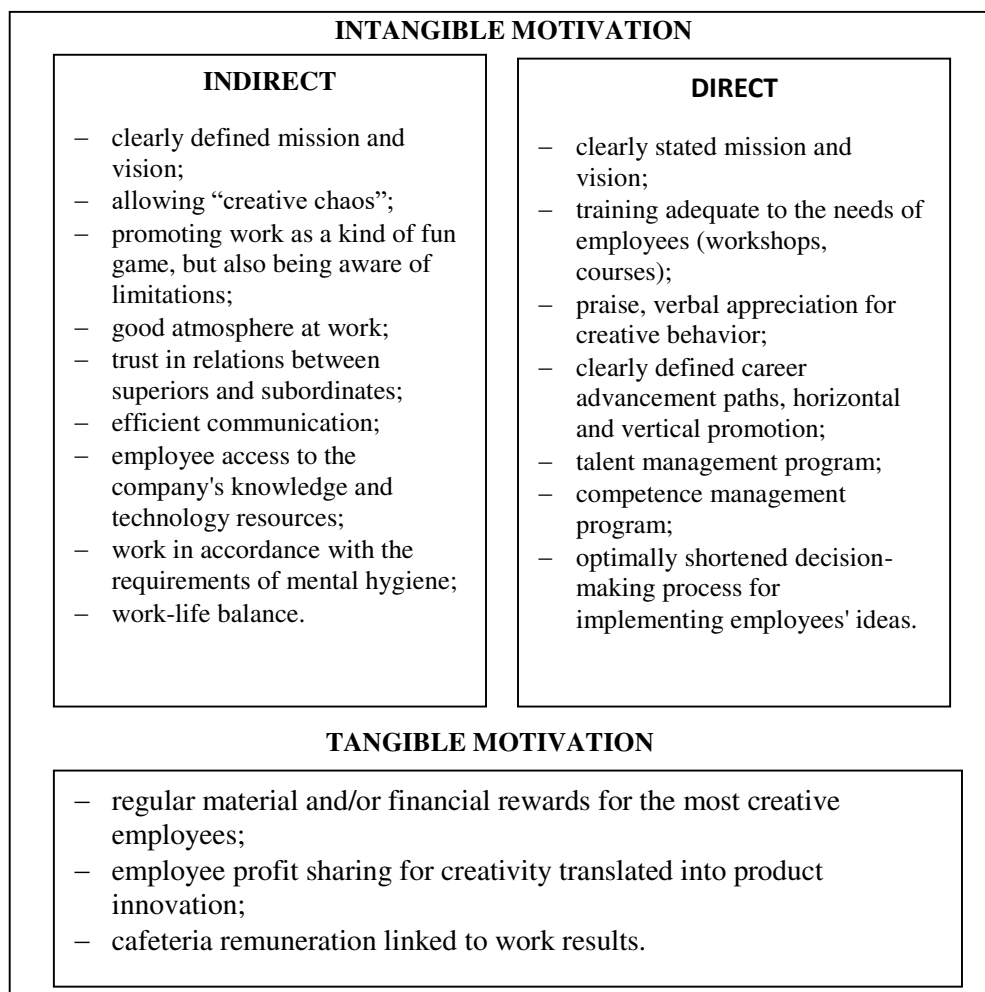
- an openness to new ideas, unconventional thinking, thinking outside the box,
- being curious, observing the environment, looking for new relationships and dependencies,
- a willingness to experiment, take risks, try new things,
- being patient, and not giving up.

Among the methods that promote the generation of innovative solutions are (Pęcek, 2018:

- brainstorming, a group technique in which participants exchange ideas in order to solve a specific problem,
- design thinking, a problem-solving approach that focuses on understanding users' needs and developing solutions that benefit them,
- lean startup, a method of developing products or services that relies on rapid iterations and testing ideas with customers, and
- group of invention methods, in which the choice of each method is matched to the stage of solving the problem.

Creating a pro-innovation culture and creative activities require strong motivation. The selection of methods and tools requires knowing: the team, the jointly developed rules and set goals (according to the SMART rule), and the availability of resources (Czerwińska-Lubszczyk, Grebsli et al., 2022; Prońko, Wojtasiak, 2016).

Motivation is the process that drives our actions (Moczyłowska, 2012). It is a complex phenomenon influenced by both internal and external factors (fig. 2).



**Figure 2.** Constituent parts of the system that motivate creative behaviors.

Source: Own elaboration based on Moczyłowska, 2012.

A different division of tools is related to the emotions that it evokes: positive and negative motivation. Negative motivation is more often used in practice. It is based on fear, and it is cheaper. To a certain extent, it devastates personality. In the long term it is ineffective, stifling the creativity so essential to the creation of innovative solutions (Wiśniewski, 2016; Żukowska, 2017).

In contrast, positive motivation leads to higher ambition. It is based on the assumption that people strive for success, social approval, and admiration, and that they want to gain this through action. It contributes to a creative atmosphere of work, support, cooperation, and communication (Wisniewski, 2016; Zhukowska, 2017).

Creating an incentive system requires a leader not only to know management theories but also to have experience and, above all else, to involve team members and know them.

It is worthwhile for a leader to be guided by the principles of motivation of McGinis (2005), which are still valid:

- Expect the best from the people you manage.
- Notice the needs of others.
- Set high standards of excellence.
- Create an environment where failure does not mean losing.
- If someone has the same goal as you, join them.
- Use role models and take pride in achievements.
- Show appreciation and praise achievements.
- Use a mix of positive and negative reinforcement.
- Make moderate use of the need for competition.
- Praise cooperation.
- Allow tensions to happen in the group.
- Try to keep your own motivation high.

Moreover, a leader should (Duda, 2021; Głowienka 2021):

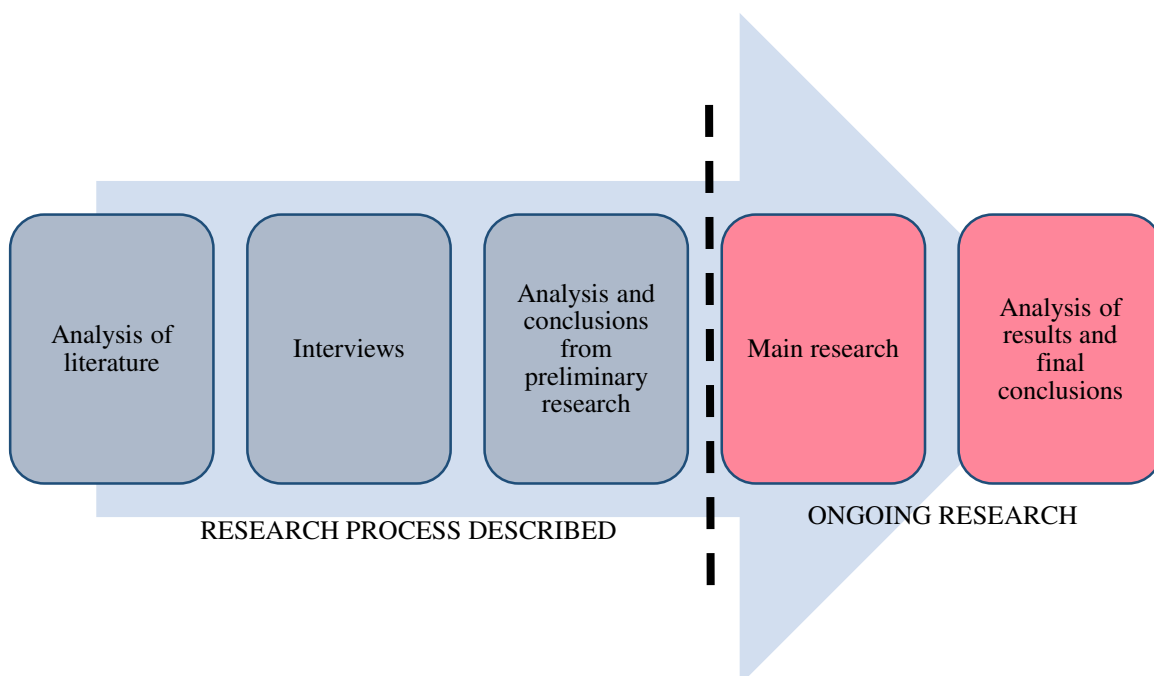
- Set realistic goals – Goals should be challenging but realistic. If goals are too difficult to achieve, they can discourage people and lower their motivation.
- Point to personal benefits – People are more motivated to do things that benefit them. Show how their actions will affect their personal development, career, or personal life.
- Assign tasks that give satisfaction – People are more motivated to perform tasks that they find interesting and rewarding.
- Reinforce a sense of being important – People feel more motivated when they feel appreciated and needed.
- Create a positive work environment where everyone feels respected and supported.
- Be a good listener, show interest in team members, in what they have to say.
- Be authentic and sincere, but also be positive and enthusiastic and inspire action.
- Be consistent – For motivation tools to be effective, they must be used regularly.

Equally important, the incentive system must be known and accepted by employees. Studies show [Pęcek, Walas-Trębacz, 2018] that not all team members understand and are familiar with the incentive system, which can definitely hinder its effectiveness. These systems are often too complex, formalized, and not aligned with the team's expectations.

So how does one create an effective system, and what tools and methods should be chosen? We attempted to answer these questions by conducting research.

#### 4. Research methodology

The primary goal of the research is to develop a set of good motivational practices for the development of an organization's pro-innovation culture. Specific goals included identifying the tools and methods of motivation used to build a company's pro-innovation culture. The research presented here is a selected part of a broader investigation into how innovative companies operate (fig. 3). In addition to motivation, this research will cover factors such as the role of leadership (Hakim et al., 2023; Nabi et al., 2023), interorganizational linkages (Wipulanusat et al., 2020; Zhao et al., 2023), and trust (Krot, Lewicka, 2020). It should be noted, however, that interesting conclusions and recommendations can already be drawn at this stage of the research, which will be presented in the article.



**Figure 3.** Research procedure.

The research covered a wide range of Polish and international literature. This was followed by interviews with innovation project leaders on the tools and methods of motivation used by them.

Interviews with individual project leaders lasted about 2 hours and were conducted in April 2023. A limited number of people took part in the interviews, with only 24 out of the 126 leaders invited agreeing to answer questions. Leaders participating in the study implemented projects funded under Priority Axis I, Innovative Economy, Measure: 1.1 R&D projects of enterprises (I Oś Priorytetowa Innowacje w Gospodarcze, Działanie: 1.1 Innowacje w przedsiębiorstwach). To structure the interview process, main and supporting questions were prepared (Table 2).

**Table 2.**  
*Research tool*

Main questions	Supporting questions
Have employee preferences regarding the tools of motivation been explored?	List the main tools.
Was the incentive system agreed upon, accepted by the employees?	What kind of emotions did it evoke among employees?
What tools of tangible motivation are used during project implementation?	Which are the most effective or most desired by employees?
What tools of intangible motivation are used during project implementation?	Which are the most effective or most desired by employees?
Which forms of motivation – positive or negative – do you value most?	Why?
Which incentive tools or methods are most effective in creating a creative work environment?	List them, giving examples.
Are decisions made together with the team?	Give examples.
Do employees have the freedom to organize their work?	To what extent? Give examples.
What are your tips for creating a pro-innovation culture in an organization?	Give examples of their application.

Conclusions from the interviews can give a rationale for further research and are also a kind of collection of good practices.

## 5. Results

Despite widespread knowledge regarding the effectiveness of an incentive system that is developed together with employees, it is not a common practice. Only 4 leaders involved the team in the development of the incentive system, obviously within the framework adopted by top management. It is worth noting, however, that in informal conversations, at staff meetings, there were proposals from employees to introduce specific motivational tools, for example: a 4-day work system for the most effective team members, the introduction of flexible working hours, or the establishment of a budget for training and qualification improvement.

All leaders responded that the incentive systems implemented were understood, accepted, and widely known by employees. Importantly, almost all pointed to the need to modify the system during the project and to adopt it to the changing environment and employees'

expectations. Among the examples repeatedly mentioned were a supplementary healthcare system (during the pandemic), and the possibility of switching to remote work. Interestingly, leaders unanimously said that changes to incentive systems were implemented smoothly and quickly. In only one case these changes led to a conflict among the team, which, however, was relatively quickly resolved (for example, MultiSport cards for employees, objection by those who do not participate in sports).

The most popular methods and tools of tangible motivation included (in order of prevalence):

1. high salary,
2. performance bonus,
3. healthcare benefits,
4. promotion opportunities (higher salary),
5. Employee Welfare,
6. paid training courses/sessions,
7. company car,
8. free or subsidized lunch,
9. team-building trips, and
10. multiSport card.

The most popular methods and tools of intangible motivation included (in order of prevalence):

1. good, friendly atmosphere at work,
2. flexible work system,
3. opportunity to work remotely,
4. autonomy in organizing work,
5. praise, recognition,
6. participation in management processes,
7. sense of community,
8. good relations with superiors,
9. allowing trials and errors, and
10. no dress code.

The leaders unanimously noted that positive reinforcement creates team spirit and a supportive atmosphere, and contributes to the achievement of expected results. It also facilitates self-development of employees and encourages their commitment; therefore positive reinforcement should dominate the process of motivation.

According to the leaders, the tools particularly contributing to a creative work environment included:

- organizing workshops and training sessions on stimulating creativity and generating innovative solutions,
- creating mentoring programs in which experienced innovators support beginners,



- offering rewards and recognition for innovation,
- creating platforms for sharing ideas among employees, and
- supporting employees in taking risks and experimenting.

Subsequent questions showed that as the maturity of the team increases, the autonomy of individual team members grows. Not all employees value the opportunity to participate in management processes; sometimes it is an additional burden for them. However, each of them appreciates the autonomy of action, the ability to organize their tasks and work time.

## 6. Conclusions

High work motivation is the basis for employee loyalty and commitment to their job duties. The process of motivation is inextricably linked to the culture of the organization. To create the conditions and space for innovation, it is necessary to create a work environment in which mistakes encourage further efforts, where communication and cooperation are prioritized, and where the exchange of ideas and creative sessions are standard.

The research resulted in a set of guidelines for creating a pro-innovation culture in an organization. This set can become a book of good practices, especially for less experienced leaders:

- Consider incorporating a high salary, performance bonuses, and healthcare benefits as motivational tools.
- Pay attention to creating a good, friendly atmosphere at work.
- Consider implementing a flexible work system and explore the possibility of remote work.
- Create space, place, and time to exchange thoughts and insights. This is how innovation is born.
- Allow mistakes, tolerate risk – this is the way to innovation.
- Ensure team diversity.
- Do not be a control freak.
- Allow yourself and the team some rest.
- Celebrate successes, drive the team to action.
- Whatever worked yesterday does not have to work today.
- Ask for help, teach this difficult art to others.
- Be a cautious optimist.
- Constantly develop yourself, take care of the development of team members.
- Sports. It is important for everyone to be in good shape.
- Teach methods to stimulate creativity.

- Be consistent (reward and punishment is systematic).
- Constantly integrate the team, allow conflicts (this clears the atmosphere).
- Use external sources: demand innovation, clusters, blue ocean strategy.
- Make use of technological developments, keep up with novelties, and let them support the team.
- Foster communication.

The literature analysis carried out identified a research gap. The number of publications retrieved and their content indicate the need for further research in the field of motivation for the development of an organization's pro-innovation culture. The research should be further expanded and complemented so that its conclusions are complete and take into account the diverse characteristics of organizations.

Motivation is one of the key factors in developing a company's innovation potential, but it is not the only one. The main research is focused on, among other areas, the function of the leader, cooperation with the company's environment, and trust.

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## ROLE OF MIGRANTS IN ELDERLY CARE. LABOUR MARKET PERSPECTIVE: REVIEW OF THE LITERATURE

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**Purpose:** This paper reviews the literature on migrants in elderly care regarding their involvement in the host country's labour market. The study aimed to find the most commonly used research methods and what topics are popular when studying this phenomenon. It is needed because of the ageing of the population, particularly in Europe, and the growing interest in employing migrants in senior care.

**Design/methodology/approach:** Fifty-seven articles selected from Web of Science (WoS) and Scopus databases were analysed. I took only articles published in English into account. They were selected based on an analysis of abstracts. The MAXQDA software was used.

**Findings:** The literature review showed that there are three main themes concerning migrants in senior care: labour market and institutional aspects, qualification aspects, and individual aspects. Very little is known about the long-term impacts of using migrant workers in elderly care, including how it may affect the local community. We know too little on the impact of migration restriction and immigration policies on the elderly care workforce. There is a gap in knowledge in relation to economic aspects of migrant work in elderly care.

**Research limitations/implications:** The literature review has limitations. First, there may be a lack of consistency in the methods and outcomes reported across studies, making it difficult to compare and synthesize the findings. Secondly, it's time-limited and does not include the most recent studies, which can lead to an incomplete picture of the current state of research. Thirdly, the findings of literature reviews are not generalizable to other populations or contexts. Because policies towards migrants in elderly care vary from country to country.

**Originality/value:** The literature review showed that there is a gap in knowledge, especially about economic aspects of migrant work in elderly care, regarding the presence of migrants in senior care in Central and East European Countries (CEE). The recommendation for future research is to look at how migrant workers in elderly care interact with local labour markets and to what extent they meet the demand for care work.

**Keywords:** migrant, elderly care, senior care, labour market, care work.

**Category of the paper:** Literature review.

## 1. Introduction

Due to ageing populations in developed countries (Balachandran, de Beer, James, van Wissen, Janssen, 2020), the demand for elderly care services is expected to increase (Residential care in Europe, 2021). OECD estimates that by 2060, the number of people over 65 in the workforce will double in G20 countries. The share of over-80s will triple (Rouzet, Sánchez, Renault, Roehn, 2019). This raises enormous challenges. On the one hand, for the labour market, because the number of potential employees is decreasing. On the other hand, the ageing population is a huge challenge for healthcare and senior care. Demand for these two services will rise. There will be increased expenditure on long-term care, which will be provided less and less by children (because fewer and fewer young people live near their parents). One solution to this critical challenge may be using new technologies (ILO/OECD, 2019). However, technology cannot completely replace humans in LTC. The solution may lie in employing migrants in health care and directly for elderly care. Especially working in the former area raises challenges, among others, related to the recognition of qualifications (Khan-Gökkaya, Mösko, 2021). According to research carried out in Melbourne, approximately 50-70% of elderly caregivers' home staff are immigrants. Many are university graduates who, due to the status of a migrant, perform the simplest work (Montague et al., 2011). Research shows that in Germany nearly 1/3 of families rely on paid elderly care (Pew Research..., 2015). Elderly caregivers in Germany derive mainly from Eastern European countries, including Poland (Elrick, Lewandowska, 2008; Helma Lutz, Palenga-Möllenbeck, 2010).

The involvement of immigrants in elderly care has been investigated for many years by developed countries with ageing populations, including Western Europe (Elrick, Lewandowska, 2008; Gallo, Scrinzi, 2016; Horn, Schweppe, Böcker, Bruquetas Callejo, 2019; Leiber, Rossow, Österle, Frerk, 2021), Canada (Hanley, Larios, Koo, 2017; Oishi, 2008), and Japan (Saraswati, 2017). There is a growing interest in this issue in Central and Eastern European countries. Until recently, some of them, such as Poland (Kubiciel-Lodzińska, Maj, 2021); the Czech Republic (Ezzeddine, 2014), and Hungary (Szeman, 2012), were regarded as countries that "export" carers of elderly people (Kniejska, 2018).

The issue of senior care is interdisciplinary and is of interest to various sciences: sociology, gerontology, economic anthropology, demography, and medical science. This is because it is a complex phenomenon affecting various socio-economic life aspects. The literature shows that previous investigations on the involvement of migrants in elderly care concentrate, among other things, on the following elements: how families and elderly people approach care provided by migrants (Salami, Duggleby, Rajani, 2017); working and living conditions of migrants (Fisher, 2021); problems, including health problems, faced by migrants and how they cope with them (HO et al., 2021); and migrants' work in elderly care in a particular country (Turnpenny, Hussein, 2022; St-Amant et al., 2021). A new issue addressed in the research is senior care



provided by migrants during COVID-19 (Gahwi, Walton-Roberts, 2022; Giordano, 2021; Sánchez, Boland, Cottone, 2022). This paper is intended to conduct a literature review in such a way as to organise the existing knowledge on the role of migrants in elderly care in the labour market of the host country. It expands the knowledge by analysing texts on the broadly understood involvement of migrant carers in the labour market. In my opinion, we know too little about the importance of migrants in supplementing the demand for senior care services and what consequences their presence has on the labour market.

The objective of the analyses was to explore the extent and nature of the international literature on the migrants employed in senior care, mainly in the context of their role in the labour market of the host country. The aim was to find a gap relating primarily to the topics addressed in the studies. The article tries to fill a knowledge gap about the phenomena (Miles, 2017).

The two research questions in this paper are as follows: (1) What are the most commonly used research methods in the study of the involvement of migrants in elderly care? and (2) What topics are popular when studying this phenomenon? To answer these questions, three goals were adopted: (1) to organise concepts and definitions that are most frequently used in the study of migrants in elderly care; (2) to verify the methodological approach and see what data are used in the study and what research techniques prevail; and (3) to identify the most frequently addressed issues on the work of migrants in elderly care that refer to their role in the labour market of the host country.

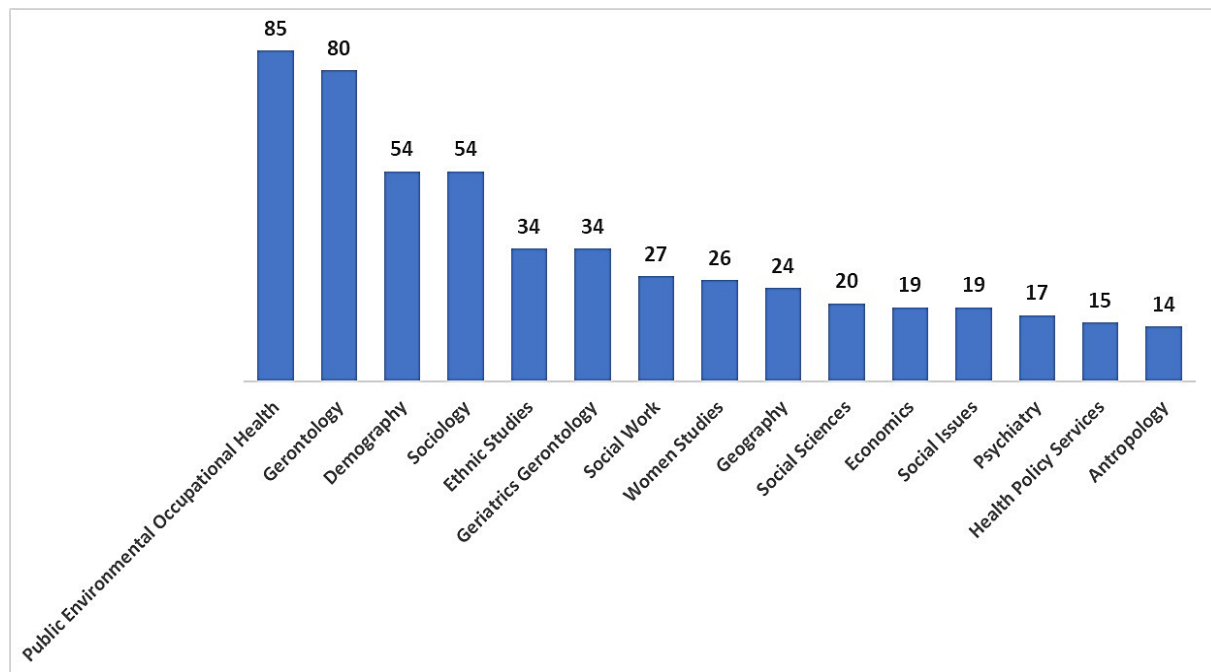
Fifty-seven articles were purposefully selected from Web of Science (WoS) and Scopus databases and analysed using the MAXQDA software. The articles were expected to discuss migrants' work as carers of the elderly and their involvement in the labour market of the host country, and more specifically, the following issues: the nature of employment, working conditions, gender role, use of qualifications, as well as adaptation of migration laws and policies to employment requirements.

This paper starts with the methodology used to review the literature. Then, it describes the articles and presents the most frequently used concepts and definitions. Next, it gives an insight into the research approaches used in the articles. Then, it discusses the main topics selected from the articles for analysis. It concludes with recommended directions for further research.

## 2. Method of data collection

Two databases (Web of Science and Scopus) were analysed. The analysis aimed to find articles and academic papers published in reviewed materials and journals. Only articles published in English were taken into account. The study covers articles published by July 2021 and analysed in the period from August to September 2021. The literature review consisted of the following stages. Step 1: pose the research question on the role of migrants working in senior care from the perspective of the host country's labour market.

Step 2: was the identification of sources and keywords. WoS and Scopus databases were searched. The search of records in the Web of Science database was performed by searching for the keywords under the following categories: “TOPIC” (a category that covers titles, abstracts, and keywords entered by the author), and “keyword plus” (a type that contains keywords entered by editors of the database). Additionally, the “\*” was used in the search to search for all terms that include the part entered. As a result, entering “migrant\*” searched for such terms as “migrants” and “migration” at the same time. Entering “migrant\* elder\* care\*” produced 452 articles. Fig. 1 lists the 15 disciplines that occurred most frequently.

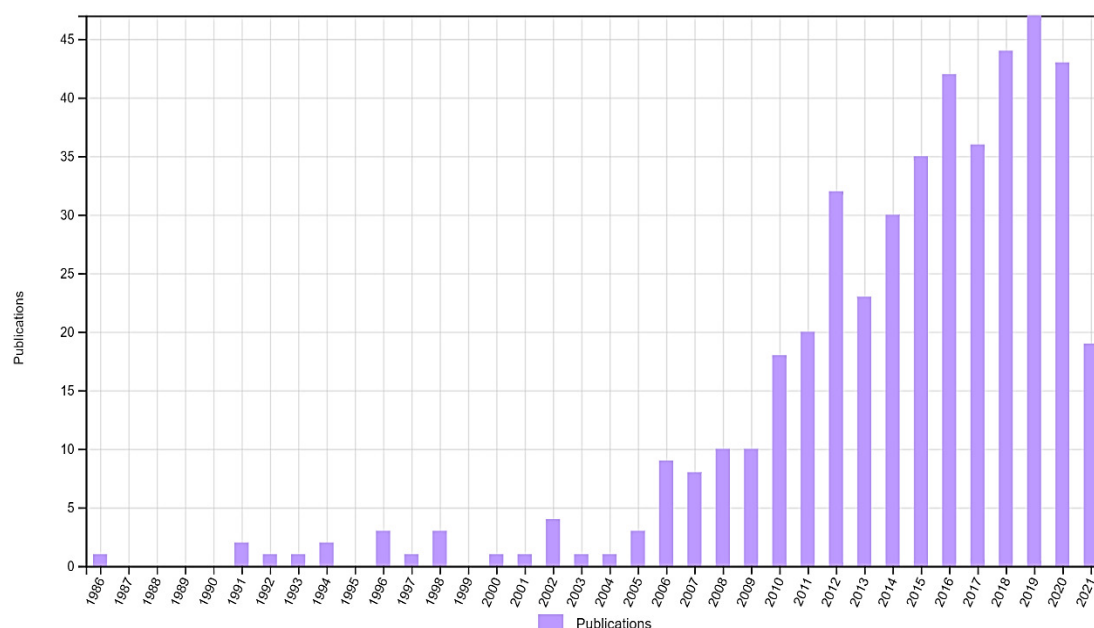


**Figure 1.** The term “migrant\* elder\* care\*” by discipline (number of texts)\*.

Records do not add up, because not all disciplines with 1 record were assigned.

Source: WoS database (as of 30.07.2021).

The publications were also analysed by year of publication. After 2006, the number of documents containing the term “migrant\* elder\* care\*” increased. Earlier, in the 1990s, this topic was much less popular. See Fig. 2 for details.



**Figure 2.** Number of publications containing the phrase migrant \* elder \* care \*, broken down by year of publication.

Source: WoS database (as of 30.07.2021).

Step 3: cleaning the databases. Among 452 records in the database, there were as many as 416 articles, 21 chapters in books, 15 post-conference materials, and 12 reviews, including 1 book review, 7 editorial materials, 7 abstracts, 3 books, and 17 early access materials. Only articles published in English were selected for further analysis.

The search of records in the Scopus database was performed by searching for the entries in the category “Article title, Abstract, Keywords” which covers titles, abstracts, and keywords entered by the author. Additionally, the “\*” was used in the search engine to look for all terms that contain the part entered. Entering “migrant\* elder\* care” searched for such terms as “migrants” and “migration” at the same time. As many as 997 documents were retrieved (as of 30 July 2021). The texts were analysed according to the discipline assigned to them. As in the case of the WoS database, high interdisciplinarity of the study was confirmed (see Table 1).

**Table 1.***Occurrence of migrant \* elder \* care in Scopus database with division into disciplines*

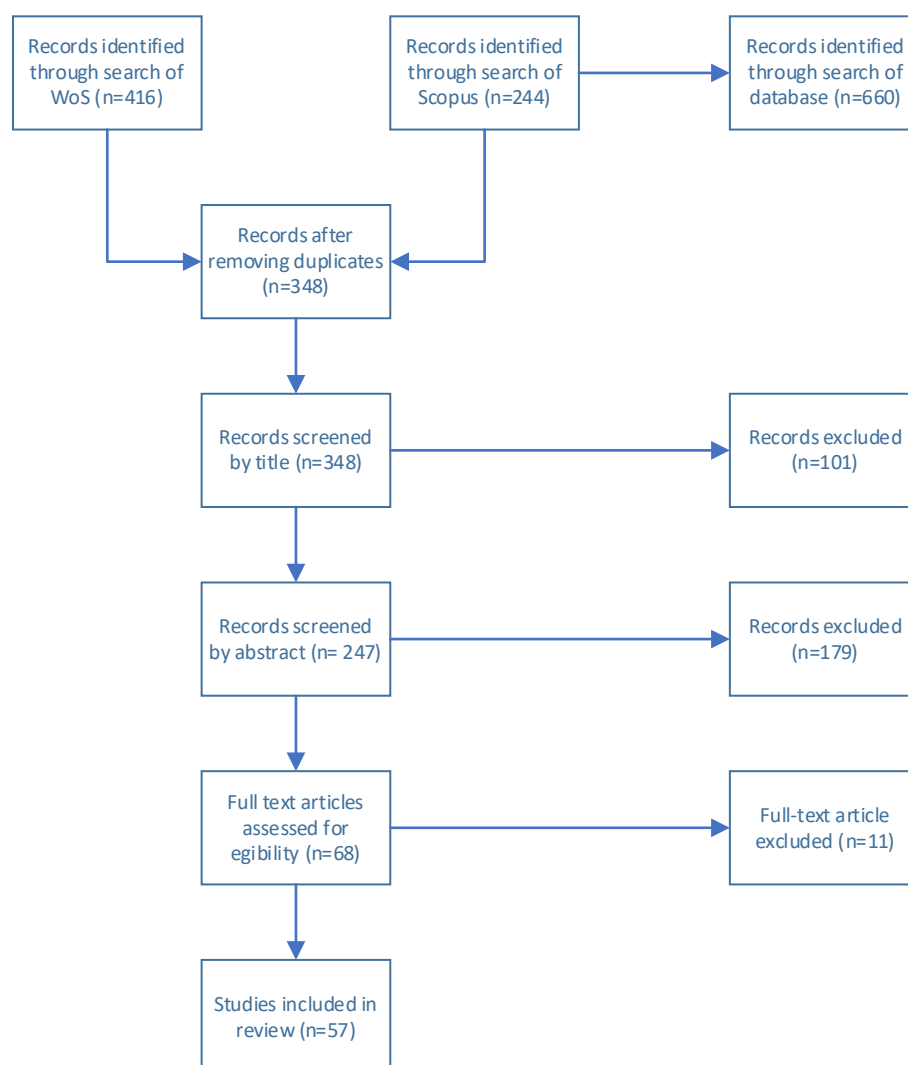
<b>Discipline</b>	<b>The number of records</b>
Medicine	550
Social sciences	344
Nursing	133
Arts and Humanities	82
Environmental Science	48
Psychology	47
Biochemistry, Genetics and Molecular Biology	27
Business, Management and Accounting	18
Economics, Econometrics and Finance	14
Multidisciplinary	13

Source: Own elaboration (as of 30.07.2021).

The analysis was limited to scientific articles only: 869 records were selected for further investigation. The articles show that elderly care by migrants is an interdisciplinary issue addressed in a variety of publications. Papers from the following fields were excluded from the analysis: Medical Sciences, Environmental Science, Biochemistry, Genetics, and Molecular Biology. Articles from the following fields were included in the analysis (a total of 244 articles): Social Sciences, Arts and Humanities, Psychology, Nursing, Business, Management and Accounting, Economics, Econometrics, and Finance.

Step 4: The articles retrieved from WoS and Scopus databases were moved to EndNote. In the next step, the database was cleaned and duplicates were rejected (step 5). As many as 348 articles were selected for further analysis. The articles were imported into Maxqda and the abstracts were studied. Articles relating to migrants working in senior care in the context of the host country's labour market were considered. Articles were searched for keywords such as labour market, employment, employee, women, and employee-employer relations. In addition, the abstracts were read by the author in order not to rely solely on keyword screening, as it was felt that this was not a method guaranteeing that all articles of interest to the research would be caught.

Some of the imported articles did not specifically address the issue concerned, i.e., they did not directly refer to migrant work in elderly care. Instead, they focused around care for elderly migrants and care for elderly parents of migrants. These, due to the subject, were excluded. After the analysis of the abstracts and keywords, 57 articles were selected for further study. The article selection process is shown in Fig. 3.



**Figure 3.** Flow diagram of article review process.

Source: Own elaboration.

## 2.1. Description of the articles

The articles included in the literature review come from 44 journals. Only a few journals contained more than one paper that was used in this study, i.e., *Journal of Ethnic and Migration Studies*, *Social Politics* (4 articles); *Ageing & Society*, *Journal of European Social Policy* (3 articles); *Global Networks*, *International Journal of Ageing and Later Life*, *Men and Masculinities* (2 articles each). In the remaining journals, only one paper was deemed suitable (see Table 2 for details in appendix).

The selected journals confirm the interdisciplinary nature of the topic. The papers on the involvement of migrants in elderly care were published in journals that deal with such issues as ageing, social policy, demography, and women's studies. There were only five journals in the field of economics, which may indicate that economic researchers relatively rarely address the issue of migrant work in elderly care.

## 2.2. Basic terms and definitions used in the articles

This section identifies and discusses the terms that are most commonly used in the articles to explore the issue of migrants in elderly care. The concept of migrants in elderly care is rarely defined in the papers. It seems that this is a key concept as this group is not homogeneous (Table 3). In the articles, a migrant in elderly care is defined as a person who permanently (24 hours a day) or periodically (several hours a day) takes care of an elderly person.

**Table 3.**

*Definition of migrants in elderly care*

Definition	Source
A migrant in elderly care is most often defined as a person born outside the country of immigration who works in elderly care.	(Jönson, Giertz, 2013)
Carers of the elderly are understood as people who take care of the elderly, keeping them physically and mentally well but do not necessarily love them.	(Nicolescu, 2019)
They may include temporary migrants who come to provide work but cannot bring their families and are given permission to stay for only a few years (this is to reduce the risk of their settling in the country).	(Ayalon, 2021)
Two types of migrants working in care: those who left their countries of origin as a result of a conscious decision to work in elderly care and those who work in this sector because it was the only job they could receive.	(Simonazzi, 2009)

Source: Own elaboration.

It is pointed out that there are different forms of employment as regards care for elderly family members by migrants. This includes so-called agency-based work (through an agency) and private employment (directly by families). Consequently, there are two terms used to refer to migrant employment: migrant in the family and migrant in the market form of care (van Hooren, 2012).

The researchers also define the concept of care, making a distinction between “caring for” (practical action) and “care about” (affective concern). The former refers to specific actions taken towards the elderly while the latter concerns all activities, not directly related to taking care of the elderly, that carers have to perform in connection with their work (Nicolescu, 2019). Ayalon defines the concept of care in a slightly different way (Ayalon, 2021). He claims that care can be understood as personal (e.g., help in everyday activities, such as feeding and washing), instrumental (e.g., help with transport and financial management), emotional, or financial support.

The literature often refers to the concept of global care chains, defined as a series of personal connections between people around the world based on paid or unpaid care work (Isaksen, 2012; Lovelock, Martin, 2016). It is about shifting care down the hierarchy of gender, class, race, and nationality. People who work in care are most often found in the lowest segments of this chain.

The concept of global care chains has evolved into care diamonds. It is understood as the participation of different actors in the provision of care to the elderly. This includes, among other things, family, relatives, services offered by the market, and services provided by the state. As noted, the provision of care requires the involvement of many different institutions in this case. However, researchers point out that the role of labour migration brokers in this process has yet to be sufficiently recognised (Chau, 2019). It is also recommended that care chains should be identified in a transnational context, and further at the institutional level, as this allows a better understanding of the transnational dynamics of global care migration (Palenga-Möllnbeck, 2013).

In a growing number of countries, care for children, people with disabilities, and the elderly is being transformed into a type of good provided by the market. To describe this phenomenon, new concepts have been introduced in the literature: marketisation of care, understood as the process of marketisation of elderly care services (Shutes, Chiatti, 2012), and care customers (i.e., people who seek elderly care services). Other terms used in the literature include “marketisation of intimacy” and “commodification of care” (Farris, Marchetti, 2017).

Outsourcing of care services for the elderly is an example of the commodification of so-called reproductive work and care work. The two terms are closely related, but they are not synonymous. Reproductive work concerns livelihood activities, including, inter alia, preparing food, shopping, washing, preparing clothes, socialising children, and providing emotional support for adults. Currently, reproductive work is increasingly being replaced with care work. Care work is about caring for dependent adults and children in terms of cooking, cleaning, care, and providing love and attention. Care work can be carried out both at home and in institutions. It can be both paid and unpaid and both formal and informal (Palenga-Möllnbeck, 2013).

To highlight the increasingly important role of immigrants in elderly care, researchers also use the term “ethnicisation of senior care” in the literature discourse (Pelzelmayer, 2016). This concept describes, inter alia, the prevalence of some nationalities in elderly care. For example, in Europe, it refers to Central and Eastern European women (Pelzelmayer, 2016) and women from the Philippines (Ayalon, 2021; Lovelock, Martin, 2016). Researchers also use the term “care migrantisation” defined as the prevalence of migrants in care. In some countries, care tasks have even been outsourced to migrants (Kim, 2018; Ranci et al., 2021).

Hence, some researchers decide to investigate the so-called care regime. The concept of care regime applies to complex regulations as well as political and cultural factors that determine how care is organised in the country (Da Roit, Weicht, 2013; Simonazzi, 2009).

Due to the COVID-19 pandemic, migrants working in elderly care are being perceived in a different way than before. Migrants working in socially important spheres of the labour market, such as elderly care, are now called essential workers to indicate that they are essential for the proper functioning of societies (Pandey et al., 2021).

The issue of senior care provided by migrants is a broad one. Various terms are used to describe it. Especially in recent years, those referring to care regimes.

### 2.3. Most frequently used research methods

A study on migrants in elderly care is challenging due to the need to recruit respondents. The difficulty stems from several factors. Firstly, the employment of migrants in elderly care is heterogeneous. Some live with their client (living-in) while others rent a flat and provide care work on an hourly basis (living-out) (Gallotti, 2009), which affects the availability of respondents. Secondly, foreigners who care for the elderly are usually hired by households and work illegally (Van Hooren, 2010), so they want to stay hidden. Thirdly, since migrants are employed illegally (Di Rosa et al., 2012), families that do so do not want such information to “spread,” either. Consequently, the work of foreigners in elderly care can be considered to be “doubly hidden.” Fourthly, working directly at the home of an elderly person as well as the lack of the need (and the lack of ability) to contact the community as such considerably hinder the implementation of research in this category of migrants from the methodological and practical point of view. Fifthly, migration is temporary, which means that respondents do not live permanently in the country of immigration. Instead, they come only for a certain period to work. All these factors make it difficult and challenging for researchers to induce migrants working in elderly care to participate in the study (Hipp, Kohler, Leumann, 2019).

The articles analysed in this paper were checked against the research methods used in them and the way the study was carried out (see Table 4 for details – in appendix).

A qualitative approach prevailed in the articles. As a rule, in-depth interviews among several dozen migrants were used in the study. Observations were also applied. The information gathered is sometimes supplemented by the employer’s opinion (interviews with elderly people and/or their families). For research purposes, the literature, documents, and reports were also analysed. When selecting respondents (migrants), snowballing and RDS analysis were used. These are the most frequently used techniques for reaching groups that are hard to reach (Kubiciel-Lodzińska, 2021; Adedeji, 2019; Bilsborrow, 2006; Górny, Napierała, 2016). The summary shows that studies on immigration in the care sector, including in particular senior care, are extremely challenging for researchers. In most of the articles, the study of migrants working in elderly care was based on no more than a few dozen respondents. Quantitative studies were far less frequent. In the group of analysed articles, they were indicated in seven papers. Research methods included among others, a letter survey (Jönson, Giertz, 2013), telephone survey (Behtoui et al., 2020), and face-to-face interviews (Di Rosa et al., 2012; Shutes, Chiatti, 2012). In the analysed articles quantitative and qualitative research were most commonly used. Secondary research methods were used seldom.

The study was carried out mainly in Western European countries but also in Singapore, New Zealand, Canada, Israel, and Japan. It is noticeable that there is a lack of research carried out in Central and Eastern European countries and that quantitative studies are rarely used. These were mainly statistics, reports, and articles.



This shows that in the future research on migrants in senior care, it is worth introducing a greater methodological rigour. If possible, including larger groups of migrants in the study. An exciting look at the issue of senior care is the implementation of research that combines the perspective of the employer and migrants working as live-in and live-out caregivers.

### **3. Findings**

The selection topic was critical issues regarding the role of migrants working in elderly care in the labour market. Fifty-seven articles that met the selection criteria were analysed. The results of the thematic analysis are presented below. The results have been grouped into three main themes: labour market and institutional aspects, qualification aspects, and individual aspects.

#### **3.1. Labour market and institutional aspects**

Working in elderly care is considered to be unattractive and relatively low-paid, involves difficult working conditions, and fails to offer opportunities for development (Picchi, 2016). It is generally limited to the three Cs: cleaning, caring, and catering. It is easy to get into this job, but at the same time, it is restrictive and not very promising (Doyle, Timonen, 2009). As confirmed in the literature, care often represents an increasingly growing part of the services, although it is still undervalued in the labour market (Huang et al., 2012). Migrants fill the gaps in elderly care that occurred in the labour market as a result of, among other things, the changing role of the family in this field (Palenga-Möllenbeck, 2013) and the need to “transfer” the care of an elderly family member to an external institution or carer. They usually take up jobs in areas that are not attractive for domestic workers and thus are not competitive (Simonazzi, 2009). Moreover, informal employment prevails in this sphere (Asato, 2017).

The progressive importance of elderly care results, *inter alia*, from the dualisation of the labour market (Hussein et al., 2013; Ranci et al., 2021). Researchers mainly highlight the impact of changes in the labour market and the increase in demand for elderly care services resulting from the occupational activation of women caring for the elderly and the aging of populations in developed countries (Picchi, 2016). The gap in the market for care services is due to the demand for cheap workers, and migrants, fall under the category (Shamir, 2013; Simonazzi, 2009).

The articles indicate the semi-legal and illegal functioning of migrants’ work in elderly care (Asato, 2017; Naumann, Stoetzer, Pietrantuono, 2018; Schmidt et al., 2016). It is estimated that 80–90% of carers coming from Eastern Europe are employed informally in Germany (Nowicka, Bartig, Schwass, Matuszczyk, 2021). Researchers also investigate the nature of employment. It is shown that migrants, e.g., in Korea, are mainly involved in informal care provided at homes

(Kim, 2018). Researchers point out that the stay of migrant carers is most often temporary, lasting 6-12 weeks (Nowicka et al., 2021). These are so-called circular migrants. As the study shows, in the sphere of elderly services, migrants are even not expected to stay permanently. One of the representatives of the surveyed employment agencies gave more insight into this: "Imagine: a woman comes here as a live-in care worker, starts to save money, and starts to pay rent for her own apartment. And then her boyfriend joins her (...), they live together. Maybe they have two kids then. Now, (...) is this woman supposed to sleep, to live with the care-recipient? Forget it! (...) This model is not suitable for residents. (...) As soon as they are permanently here and they live here, they are never going to accept a job like that" (Chau et al., 2018).

The area of study explored more extensively today is the role of employment agencies in the employment of migrants for elderly care (Chau, 2019; Elrick, Lewandowska, 2008; Leiber, Matuszczyk, Rossow, 2019; Leiber et al., 2021; Pelzelmayr, 2016). For example, researchers found that some employment agencies in Austria recognised the potential of migrants working in care and decided to act as an agent between families wishing to employ a migrant and migrants willing to take up care work (Schmidt et al., 2016). This results from the increasingly noticeable marketisation of care services for elderly people. Elderly care, provided by the family in many countries until recently, is now passed on to outside parties, hired specifically for this purpose (Bartha, Zentai, 2020; Farris, Marchetti, 2017; Kim, 2018; Nicolescu, 2019; Picchi, 2016; Ranci et al., 2021; Schwiter et al., 2018; Shamir, 2013; Shutes, Chiatti, 2012). Researchers also found that employment agencies and their recruitment practices are contributing to the preservation of the processes of migration of women from Central and Eastern European countries to Western European countries (Chau, 2019). Moreover, agencies also influence the image of migrants in elderly care and show their experience e.g., by referring to age, as revealed by one of the representatives of an employment agency from Switzerland: "Most of our women are between 45 and 60. We don't have women under 30". According to the respondent, middle-aged women who have brought up their children have many advantages: they do not feel the pressure of being separated from their children, are more willing to accept difficult working conditions, value being at home, and are reluctant to stay permanently, preferring to return to their families (Chau, 2019). Furthermore, the process of institutionalisation changes over time, with the diminishing role of agencies. The literature identifies three stages of network development: agent-dominated, pioneer-dominated, and follower-dominated. In the first stage, migration is driven by agents who recruit new migrants. In the second stage, experienced migrants take over the role of agents, building their network of contacts. In the third stage, developed networks of migrants use the knowledge of other migrants to take up jobs in the industry (Elrick, Lewandowska, 2008).

There are also reports on the regulations that govern the labour market in the field of elderly care provided by migrants (Bachinger, 2010, 2015; Casanova et al., 2020; Cohen-Mansfield et al., 2019; Di Rosa et al., 2012; Salami, Meherali, 2018; Scrinzi, 2010). In Norway,

for example, nurses could obtain work permits for one year. The recognition of their qualifications was challenging. The articles show that the process was not easy. Women were required to know the language and have additional qualifications in geriatrics and psychology (Isaksen, 2012). Austria formalised the status of 24-hour care providers and introduced subsidies for employers to improve, *inter alia*, the quality of the services provided and reduce the informal economy (Schmidt et al., 2016). Canada launched the programme that allows people to come to work in elderly care without having to fulfil the requirements under the immigration points system. However, the condition is that care is provided to an elderly person at home for at least 24 of 36 months (Bourgeault et al., 2010). Israel also opened up to migrants willing to work in elderly care (Shamir, 2013). The study shows that cash-for-care programmes only stimulate an influx of migrants into home-based elderly care if the person entitled to the programme is authorised to make all decisions in this respect (Da Roit, Weicht, 2013).

For comparison, the situation in Italy, England, and the Netherlands is investigated. In Italy, employment by families (“migrant in the family model”) prevails. In England, the key role is played by agencies providing care services (“migrant in the market model”). In the Netherlands, it was not possible to identify the prevailing model of migrant employment in elderly care (van Hooren, 2012). Further, the systems of Spain and Sweden are compared. It was found that there are many differences between the countries, but also one common thing, the so-called “migrant precariat” (Hellgren, 2015). Asian countries also exhibit different approaches to outsourcing of care. Taiwan (Asato, 2017), Hong Kong, and Singapore follow a liberal approach, according to which elderly care is provided through services available on the private market, often including the employment of migrants. Japan and Korea have a predominantly institutional approach, promoting the financing of long-term elderly care through the insurance system, encouraging the employment of native workers, and limiting foreign ones (Lan, 2018). The elderly care system in Italy and the search for innovative systems to meet the demand in this respect are described by Casanova et al. (2020).

### **3.2. Qualification aspects**

Work in elderly care is perceived as being unqualified and mainly attracting unskilled people (Di Rosa et al., 2012). Many migrant carers received no formal training for their job (Nowicka et al.). A study made in Canada shows that the level of training among migrants is often higher than would be required for this job (Bourgeault et al., 2010; Martin-Matthews et al., 2010). Even higher than that of native workers employed in the field (Martin-Matthews et al., 2010), and sometimes higher than that of employers (Lyberaki, 2011). However, due to the ageing of the population, it is not possible to meet the demand for care services with skilled native workers or people from countries with similar levels of development because of their high wage demands (Palenga-Möllenberg, 2013).

As taking up a job in elderly care does not require special qualifications in general, the literature uses the term “paraprofessional” to describe migrants without qualifications or licenses to work in elderly care (Ayalon, 2021). However, some studies seem to contradict the belief that working in elderly care does not require qualifications. A study from Singapore shows that people taking up a job in this field are expected to have professional skills (Ortiga et al., 2021). This is also the case in Great Britain where it was easier to obtain a work permit for a person “qualified” to work in the care sector (Shutes, Chiatti, 2012).

Note that the literature links the concept of skills with so-called soft skills, i.e., the ability to give emotional support to older people (Giordano, 2021; Ibarra, 2002; Cohen-Mansfield et al., 2019; Lan, 2018; Nicolescu, 2019). Similarly, the papers studied address the skills of the perfect carer of the elderly person in terms of not only qualifications but also soft skills (Bastia, 2015; Ortiga et al., 2021). There are references to factors that make it difficult for migrants working in elderly care to use their qualifications. These include poor knowledge of the language of the immigration country (Leiber et al., 2021) and the need for recognition of the diploma (Doyle, Timonen, 2009). Researchers do not only look at factors determining physical involvement in migrants’ work but also the critical importance of emotional participation. The need to include information on emotional involvement in the curriculum of training courses for candidates for carers of the elderly is stressed (Salami, Meherali, 2018).

The study shows that elderly care jobs are mainly taken up by middle-aged women who have care experience from their education, have cared for a family member, or have completed an elderly care course (Schmidt et al., 2016). The analysed articles emphasise that women are better prepared for care work because they have a natural ability to express and perceive emotions (Palenga-Mollenbeck, 2013).

In terms of skills utilisation, the roles of male and female migrants in elderly care are compared, and significant differences between them affecting employability are identified (Scrinzi, 2010). Interestingly, men clearly separate their care work skills and qualifications from domestic work, such as cleaning and cooking. They are much more likely than women to limit their work to activities directly related to the care of the elderly and do not perform household duties. If they do, they tend to call it a favour (Hrzenjak, 2013). The study shows that male carers rationalise their work. They do not consider their activity to be subordinate. They believe that work directly related to elderly care, such as washing, is skilled work. This is how one of the respondents describes his job: „I am a medical technician with 30 years of professional experience, and for 20 of which I work in care, I’m highly qualified in this respect” (Hrzenjak, 2013).

The articles also discuss the necessary qualifications that have to be obtained to work in elderly care and the participation of migrants in courses that prepare them for this work to build a long-term elderly care system (Da Roit, van Bochove, 2017). Employment agencies run special courses in Indonesia and the Philippines to prepare qualified staff for elderly care work in Japan. Migrants spend 400 hours learning the Japanese language, preparing to perform

household duties, and understanding cultural etiquette, including how to bow (Lan, 2018). Interestingly, in some countries, migrants' qualifications may be an important factor to consider when hiring them, especially if employment agencies are involved in the process. It is not uncommon for the family of an elderly person to require that the worker offered by the agency be qualified and have a good command of the language. The lack of necessary qualifications translates into lower fees users pay (Schmidt et al., 2016). Note, however, that representatives of agencies from Switzerland did not, generally, emphasise the need to have special qualifications in the care sector. They claimed anyone can do it because it is just about domestic work (Chau, 2019).

The employment of medical staff (doctors and especially nurses) in the care of elderly people is a separate issue relating to skills utilisation (Gozdziak, 2016; Isaksen, 2012; Peters, Braeseke, 2016; Salami, Meherali, 2018; Willis et al., 2018). References are also made to the fact that medical staff, mainly nurses, waste their talent doing jobs related to the care of elderly people that are below their qualifications (Huang et al., 2012). This is because their qualifications are not recognised in the host countries, and they cannot practise their profession. Doing such work in the long term makes them lose their qualifications (deskilling) (Adhikari, Melia, 2015).

A study made in Singapore suggests that work in elderly care is often treated more as a healthcare occupation and thus should be provided by nurses (Ortiga et al., 2021). Researchers emphasised that caring for an elderly person at home or in an institution requires a redefinition of the so-called services needed to help the elderly. The skills required in each segment may differ slightly (Simonazzi, 2009).

The analysed articles also deal with the differences that exist between high- and low-skilled migrants taking up work in elderly care. The differences between the two include the nature of the work and the motives for taking up employment (Kubiciel-Lodzińska, Maj, 2021). In addition, highly skilled migrants are more likely to work in public institutions caring for the elderly, while unskilled migrants predominate in the private sector (e.g., in Great Britain) (Isaksen, 2012). For some highly skilled migrants with a background in physiotherapy, nursing, or psychology, a job in elderly care was the only chance for employment that is at least partially related to their educational experience (Doyle, Timonen, 2009). A study made in Great Britain found that migrants from A8 countries working in elderly care had an opportunity to learn English, and those from Africa or the Philippines with a nursing background had a chance to broaden and enhance their work experience (Hussein et al., 2013).

A study made in Germany shows that the COVID-19 pandemic has led to a slight change in the expectations of employment agencies and end-users regarding the qualifications of migrants in elderly care. There is more acceptance for people with limited knowledge of the host country's language, skills, and less experience (Nowicka et al., 2021).

The utilisation of migrants' skills largely depends on a country's policy towards migrants (van Hooren, 2012). In Singapore, for example, such a policy may define the standards of care for the elderly, i.e., the skills and qualifications of the people who provide this work (Ortiga et al., 2021).

### **3.3. Individual aspects**

Women play a dominant role in elderly care. It is estimated that they represent up to 90% of workers in domestic work (Lutz, 2002). Most of the analysed studies refer mainly to women and their role in this sphere (Bastia, 2015; Iecovich, 2011; Martin-Matthews et al., 2010; Palenga-Mollenbeck, 2013). It is emphasised that the archetype of the global care chain is rooted in the image of a mother who migrates from a less wealthy country to a more developed country (Isaksen, 2012). Helma Lutz (2002, p. 99) writes explicitly that "the fact that women's socialization includes learning to be flexible, to tolerate humiliation and social degradation seems to make this kind of migration easier for women".

Care for the elderly primarily includes caring for the body. Carers often see their charges naked. Women carers can cope with this more easily. Also socially, their confrontation with the nakedness of the mentee is more socially acceptable. This is not dependent on the gender of the older person. They can care for both female and male elderly people. As the study shows (e.g., a study made in Switzerland), there is a common preference to employ women in elderly care (Chau, 2019). In some countries, due to cultural considerations, it is not appropriate for a man to take care of older women (Huang et al., 2012). The study on the role of women in elderly care also points out another important factor, i.e., double burden of women. On the one hand, women working abroad as carers become the key family breadwinners (a sphere considered to be reserved for men until recently). On the other hand, they also have caring responsibilities towards their loved ones (children and elderly parents); they are responsible for the livelihood of their families and the care of some of their members (Giordano, 2021). The analysed texts also see migrant women as catalysts for social change (Lyberaki, 2011).

The literature also discusses how male migrants act in elderly care. This kind of service is perceived as highly feminised (Hrženjak, 2013; Jonson, Giertz, 2013; Näre, 2010; Näre, 2013; Scrinzi, 2010). The studies show that men in elderly care find employment mainly when physical strength is needed, e.g., lifting patients (Huang et al., 2012).

Regarding job satisfaction of migrants employed in elderly care, it was found that the relationship between the migrant and the person being cared for is crucial (Iecovich, 2011; Martin-Matthews et al., 2010). Hence, the area of study extending the micro perspective to include the relationship between the employee and the employer is interesting (Baldassar et al., 2017; Chau et al., 2018; Salami, Meherali, 2018). The studies show that a good relationship between the carer and the person being cared for is established when the family is involved in it, but not overly. Both the carer and the person being cared for are separated from their families

and this common feature can give a sense of closeness and consequently change the hierarchical relationship between the employee and the employer (Baldassar et al., 2017).

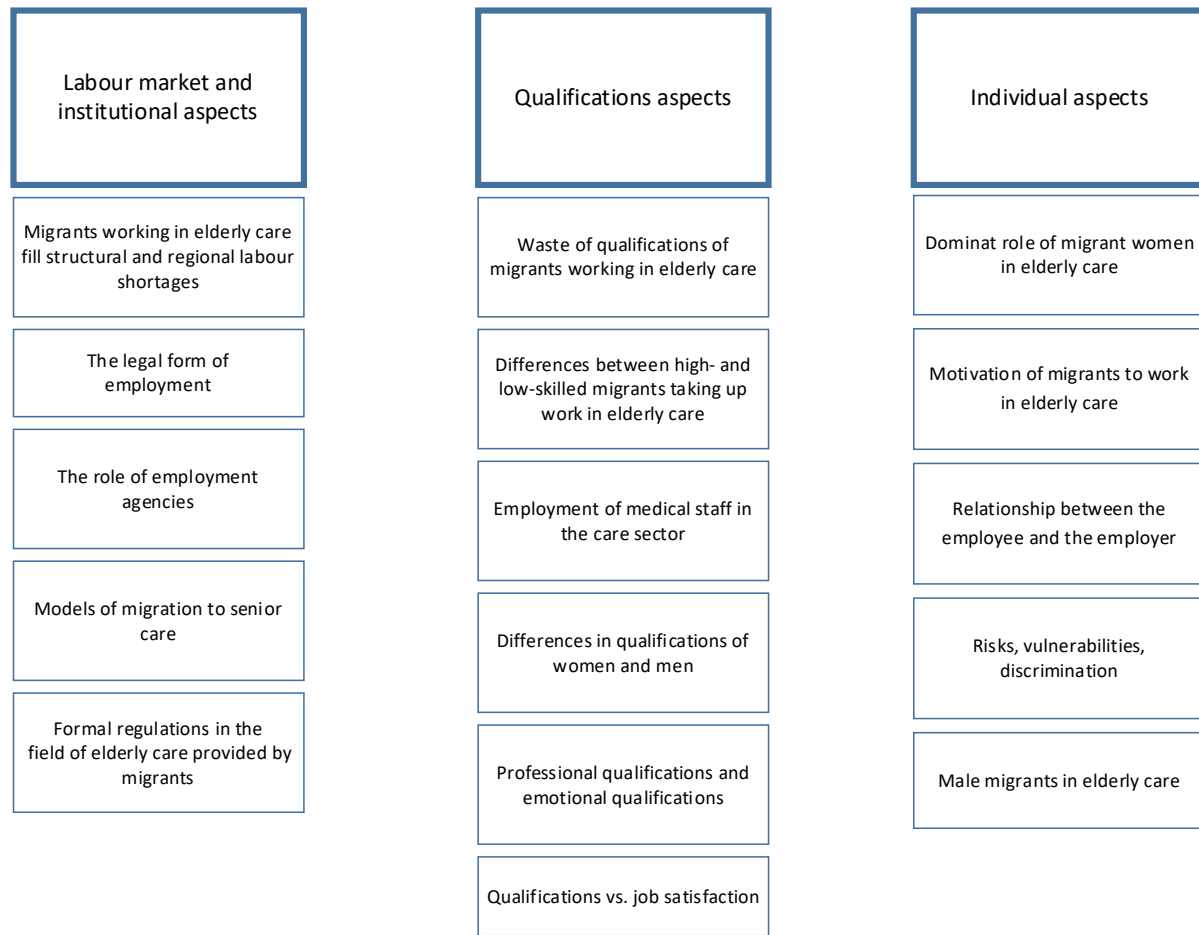
Articles also deal with the motivation of migrants to work in elderly care (Bruquetas-Callejo; Hussein et al., 2013; Liebelt, 2011). Interestingly, motivation may differ, depending on the education of the migrant, for example. A study made in Poland shows that there are differences between highly skilled and unskilled migrants (Kubiciel-Lodzińska, Maj, 2021). A study in Ireland shows differences between workers from Europe, Asia, and Africa (Doyle, Timonen, 2009). Differences in motivation for working in elderly care depending on the origin of the migrant are also shown in a study made in Great Britain (Hussein et al., 2013). Another issue analysed is the working conditions of migrant workers in elderly care (Chau et al., 2018; Figueiredo et al., 2018; Fisher, 2021; Liew et al., 2020; van Hooren, 2012).

The articles also discuss the concept of migrant precariat (Hellgren, 2015). In particular, the situation of those working in elderly care is analysed from the perspective of a group that is exposed to unequal treatment and discrimination (Behtoui et al., 2020; Lovelock, Martin, 2016). For example, a study made in Portugal found that migrants, and migrant women in particular, can be exposed to up to three types of abuse: employment-related abuse (contract, salary), psychological violence, and sexual harassment (Figueiredo et al., 2018). Their vulnerability is also because that they depend almost entirely on the person they are caring for: when such a person dies or is transferred to a hospital, they lose their jobs (Della Puppa, 2012). The inequalities that migrants working in elderly care may face may be due to the limitation of their mobility, which leads to isolation (they cannot leave home easily because they have to care for the elderly person) (Salami, Meherali, 2018). During the COVID-19 pandemic, the issue of isolation of carers of the elderly became an even more significant problem (Giordano, 2021; Pandey et al., 2021).

To summarize, the analysis of the literature also indicated the frequency of themes in the research area relating to the presence of migrants in senior care. The results are discussed in more detail in the following section.

## 4. Discussion

The literature analysis made it possible to identify the main themes of research on migrants in senior care in terms of their presence in the labour market. They were divided into three thematic areas: labour market and the institutional aspects, qualifications, and individual aspects. The themes are presented in Figure 4.



**Figure 4.** Themes identified in the literature connected with the role of migrants working in elderly care in the labour market.

Source: Own elaboration.

The articles selected for further analysis, were not limited to texts published in journals classified as economics or management sciences even though the study concerns the labour market and the use of migrants' skills. It was decided to analyse also articles from other fields. It turned out to be a good decision as the issues regarding the role of migrants in the labour market and the use of their education and qualifications also appear in articles from other research areas. The analysis of the literature showed that this topic is relatively rarely discussed in journals, typically dealing with economics or management. This may result, among other things, from the qualitative nature of the study, as was usually the case in the articles. The qualitative approach is probably because the employment of immigrants in elderly care goes beyond the scope of statistics in most countries and has a semi-legal or illegal character (Naumann et al., 2018; Schmidt et al., 2016). Studies on immigration in the care sector, particularly senior care, are highly challenging for researchers. In most of the articles, the study of migrants working in elderly care was based on no more than a few dozen respondents. Groups of several hundred migrants working in elderly care were studied in six cases only. The studies were carried out mainly in Western European countries but also in Singapore, New Zealand, Canada, Israel, and Japan. Hence, wealthy countries with ageing populations are



more important in this respect. The countries of Central and Eastern Europe may serve as a new and interesting area of study on this topic as they have not dealt with the issue of immigrants in elderly care so far. Until recently, these countries sent carers of the elderly to Western European countries in the first place. However, for some time now, they have also been host countries for immigrants (mainly from Ukraine) taking up care of the elderly. This is the case in Poland, for example, which offers a fascinating perspective in social and economic terms.

The literature on migrants in elderly care can be divided into several categories. The first category relates to labour market and institutional (mainly legal) factors. Several issues have been of interest to researchers. First, work in elderly care belongs to the so-called secondary segment of the labour market and is not of interest to native workers. This is due to several reasons: work in elderly care is burdensome (sometimes, it requires availability 24 hours a day), does not offer opportunities for promotion, and is relatively low-paid. Due to the lack of interest of native workers in taking up work in this sphere, there was a gap that migrants filled. Reference is also made to the forms of employment of migrants and the role of employment agencies in the elderly care market. In this respect, some gaps were identified. Firstly, it was noted that employment agencies show how the demand for care workers and the selection of migrants correspond to the needs and preferences of elderly people, to what extent they result from the needs of the elderly and to what extent they are shaped by employment agencies.

The second group concerns the use of migrants' qualifications in elderly care. According to the literature, work in this field is seen as unskilled. However, the studies found that both unqualified and qualified people take up jobs in elderly care. The level of education affects, *inter alia*, the nature of work (people with high qualifications are more likely to work legally), expectations from work, and motivation for taking up employment. In this respect, there are also some knowledge gaps, showing, *inter alia*, whether and how employment agencies can support migrants to better use their knowledge and qualifications by selecting appropriate employers for them.

The third group of aspects investigated is directly related to the concept of migrant (micro) (individual aspects/conditions). The studies in this area address gender issues present in elderly care. Most of the articles refer to the role of women in elderly care. The involvement of women and men in elderly care is compared. The articles also discuss the experience of discrimination among migrants in elderly care. In this respect, there are also some gaps. For example, in the studies on discrimination against migrants, there is a lack of research on wage discrimination.

Several findings can be identified. First of all, it was noticed that although the literature analysis dealt with an issue strongly related to economics (labour market and employment of migrants therein), the articles analysed rather dealt with other fields of knowledge, e.g., gerontology, demography, geography, and social sciences. A typically economic approach regarding the presence of migrants in senior care is therefore missing. Secondly, there is a distinct lack of research on migrant work in senior care in Central and Eastern European

countries. It is an essential finding that there needs to be recognition of this phenomenon in countries that, like Western Europe, have an ageing population, and no or very weak systemic solutions for senior care and the demand for care services will grow in these countries. Thirdly, we still know pretty little about the role of employment agencies fulfilling (or perhaps creating demand?) for migrant work in senior care. This is especially the case in Central and Eastern European countries. Fourthly, there is a lack of knowledge in the research on individual aspects regarding the employment of refugee women in senior care. This issue would need to be developed, given the influx of refugees from Ukraine into Europe in 2022.

## 5. Conclusions

The literature review showed three main themes relating to the presence of migrants in senior care: labour market and institutional aspects, qualification aspects, and individual aspects. Several knowledge gaps were identified. Very little is known about the long-term impacts of using migrant workers in elderly care, including how it may affect the care recipients and the local community. There is lack of research on the impact of migration restriction and immigration policies on the elderly care workforce, and its potential impact on the availability and quality of care. There is a gap in knowledge, especially concerning economic aspects of migrant work in elderly care (level of salaries, in the context of highly skilled migrants, too little is known about the steps they take to get out of under-qualified jobs and escape brain waste).

The study also brings implication for labour market policy. There is a lack of knowledge regarding the presence of migrants in senior care in CEE countries. Despite the fact that the population in these countries, as well as in Europe as a whole, is ageing, there is quite a little knowledge of how migrants complement the workforce. From the few studies conducted in the CEE countries, it appears that primarily migrant women from Ukraine took up care work here (Kubiciel-Lodzińska, Maj, 2021; Ezzeddine, 2014). The war in the country caused quite significant changes in migration processes from Ukraine to other European countries. Economic migrants were replaced by refugees. Ukrainian refugees are mostly women, but they come with their children and cannot work in long-term senior care, which they could do as economic migrants (usually, the children remained in the country of origin under the care of other family members). This is a significant challenge for the senior citizenship policies of the Central and Eastern European countries.

The recommendation for future research is to look at how migrant workers in elderly care interact with local labour markets and to what extent they meet the demand for care work. It is also worth trying to show the economic impact migrants have on the country of immigration and, through financial transfers, for example, on the country of emigration.

The literature review has limitations. First, there may be a lack of consistency in the methods and outcomes reported across studies, making it difficult to compare and synthesize the findings. Secondly, it's time-limited and does not include the most recent studies, which can lead to an incomplete picture of the current state of research. Thirdly, the findings of literature reviews are not generalizable to other populations or contexts. Because policies towards migrants in elderly care vary from country to country. This affects the situation of migrants, limits the possibilities of comparative analysis, and makes generalisations difficult. The limitation of the research is the implementation of the literature review within a specific high-impact journals and time frame and it does not include the most recent studies, which can lead to an incomplete picture of the current state of research. There are several consequences of using the Web of Science (WoS) and Scopus databases for a literature review on migrants working in elderly care. We don't have access to non-English or non-Western languages. The databases only contain publications from high-impact journals which may lead that we lose studies from certain countries and institutions. The author is aware of this, but the intention was to review the literature in mainstream science.

The research has practical implications. It concerns the use of migrants' skills. It is not uncommon for people with higher qualifications (e.g., nurses, physiotherapists) to be employed in senior care who will be under-qualified. Deskilling causes a waste of talent that could be used in the host country. This aspect is also particularly important in view of the influx of refugees from the Ukraine, some of whom also have these qualifications (Kubiciel-Lodzińska, Solga, Filipowicz, 2023). It is also worthwhile for migration policy to develop institutional and legal instruments that can support the process of employing foreigners in elderly care (e.g., legalisation of employment, caregiver agencies).

Because of the ageing of the population and the need to develop elderly care services, both formal and informal, it is reasonable to explore this phenomenon both from the perspective of migrants, i.e., under what conditions they are willing to migrate and take up employment, and elderly people in terms of their expectations regarding qualifications, skills, the origin of migrants, etc. A better understanding of this issue will allow us to understand the demand for senior elderly services better and shape a migration policy, including migration for elderly care.

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## Appendix

**Table 2.**

*Papers analysed for literature review by journal*

Journal	Subject/research area	No. of papers	Authors
Ageing & Society	Gerontology	3	(Doyle & Timonen, 2009); (Schmidt, Winkelmann, Rodrigues, & Leichsenring, 2016); (Ayalon, 2021)
American Behavioral Scientist	Clinical Psychology, Interdisciplinary Social Sciences	1	(Pandey, Parreñas, & Sabio, 2021)
Anthropology & Aging	Geriatrics & Gerontology	1	(Nicolescu, 2019)
Asia Pacific Journal of Social Work and Development	Social Work	1	(Asato, 2017)
Asia Pacific Viewpoint	Area Studies, Geography	1	(Liew, Yeoh, Huang, & Ho, 2020)
Cambridge Journal of Economics	Business & Economics	1	(Simonazzi, 2009)
Cities	Urban Studies	1	(Chau, Pelzelmayer, & Schwiter, 2018)
Critical Sociology	Sociology	1	(Lan, 2018)
Equality, Diversity and Inclusion	Business & Economics	1	(Palenga-Mollenbeck, 2013)
Ethnic and Racial Studies	Ethnic Studies, Sociology	1	(Behtoui, Boreus, Neergaard, & Yazdanpanah, 2020)
Ethnicity & Health	Ethnic Studies, Public, Environmental & Occupational Health	1	(Lovelock & Martin, 2016)
European Journal of Ageing	Geriatrics & Gerontology	1	(Hussein, Stevens, & Manthorpe, 2013)
European Journal of Social Work	Social Work	1	(Di Rosa, Melchiorre, Lucchetti, & Lamura, 2012)
Feminist Economics	Business & Economics, Women's Studies	1	(Lyberaki, 2011)
Feminist Review	Women's Studies	1	(Lutz, 2002)
Gender Place and Culture	Geography, Women's Studies	1	(Pelzelmayer, 2016)
Gender Work and Organization	Business & Economics, Women's Studies	1	(Giordano, 2021)
Geoforum	Geography	1	(Bastia, 2015)
Global Networks	Social Science	2	(Huang, Yeoh, & Toyota, 2012); (Ortiga, Wee, & Yeoh, 2021)
Identities. Global Studies in Culture and Power	Cultural Studies, Ethnic Studies	1	(Baldassar, Ferrero, & Portis, 2017)
Intenational Journal of Ageing and Later Life	Social Science	2	(Chau, 2019); (Martin-Matthews, Sims-Gould, & Naslund, 2010)
International Journal of Care and Caring	Social Sciences	1	(Leiber et al., 2021)

International Journal of Environmental Research and Public Health	Environmental Sciences & Ecology, Public, Environmental & Occupational Health	1	(Casanova, Di Rosa, Fisher, & Lamura, 2020)
International Journal of Migration, Health and Social Care	Public, Environmental & Occupational Health	1	(Salami & Meherali, 2018)
International Migration	Demography	1	(Bruquetas-Callejo, 2020)
International Review of Sociology	Sociology	1	(Hrženjak, 2013)
Investigaciones Feministas	Women's Studies	1	(Picchi, 2016)
Israel Studies Review	Area Studies	1	(Shamir, 2013)
Journals of Gerontology Series B - Psychological Sciences and Social Sciences	Geriatrics & Gerontology, Psychology	1	(Cohen-Mansfield, Golander, Iecovich, & Jensen, 2019);
Journal of Ageing and Social Policy	Demography, Gerontology, Life-span and Life-course Studies	1	(Nowicka, Bartig, Schwass, & Matuszczyk, 2021)
Journal of Ethnic and Migration Studies	Demography, Ethnic Studies	4	(Näre, 2013); (Jönson & Giertz, 2013); (Kim, 2018); (Elrick & Lewandowska, 2008)
Journal of European Social Policy	Public Administration, Social Issues	3	(Shutes & Chiatti, 2012); (Da Roit & Weicht, 2013); (van Hooren, 2012)
Journal of Immigrant & Refugee Studies	Demography, Ethnic Studies, Sociology	1	(Palenga-Möllenbeck, 2013)
Journal of International Migration and Integration	Demography	1	(Kubiciel-Lodzińska & Maj, 2021)
Journal of Nursing Management	Business & Economics, Nursing	1	(Adhikari & Melia, 2015)
Men and Masculinities	Sociology	2	(Scrinzi, 2010); (Näre, 2010)
NORA - Nordic Journal of Feminist and Gender Research	Women's Studies	1	(Della Puppa, 2012)
Journal of Population Ageing	Geriatrics & Gerontology	1	(Bourgeault, Parpia, & Atanackovic, 2010)
Social Identities	Ethnic Studies	1	(Gozdziak, 2016)
Social Policy & Administration	Development Studies, Public Administration, Social Issues, Social Work	1	(Da Roit & van Bochove, 2017)
Social Policy & Society	Social Issues, Social Work	1	(Figueiredo, Suleman, & Botelho, 2018)
Social Politics	Social Issues, Women's Studies	4	(Ranci, Arlotti, Cerea, & Cordini, 2021); (Isaksen, 2012); (Farris & Marchetti, 2017); (Hellgren, 2015)
The Gerontologist	Geriatrics & Gerontology	1	(Iecovich, 2011)
Transactions of the Institute of British Geographers	Geography	1	(Schwiter, Strauss, & England, 2018)

Source: own elaboration.

**Table 4.***Research methods used in the analyzed papers*

Author	Research method/ source of information	Number of care work respondents (migrants)	Number of respondents (care agencies, employers, others)	Country of analysis
(Chau et al., 2018)	In-depth interviews	12	20 – representatives of care agencies 2 representatives of workers organizations	Switzerland
(Kubiciel- Lodzińska, Maj)	In-depth interviews	31	-	Poland
(Nicolescu, 2019)	Participant observation, Semi structured interviews	34	24 – employers	Italy
(Pelzelmayer, 2016)	Online searches	-	Agency websites (40), scholarly and public discussion	Switzerland
(Baldassar et al., 2017)	In-depth interviews	8	10 – care receivers and their family member	Italy
(Scrinzi, 2010)	Semi structured interviews	10	20 – employers, people working in training and recruitment agencies, managers of nonprofit associations providing home care	Italy, France
(Näre, 2013)	In-depth interviews	-	12 – employers	Italy
(Jonson, Giertz, 2013)	e-mail questionnaire	177	2990 – native born elderly carers	Sweden
(Näre, 2010)	In-depth interviews Participant observation	27	15 – employers	Italy
(Kim, 2018)	In-depth analysis of documentary and statistical evidence	-	-	South Korea
(Asato, 2017)	Documents analysis Interviews	-	Interviews with ministers and elder care institutions	Taiwan
(Behtoui et al., 2020)	Telephone survey (quantitative data- gathering)	97	192 – native-born elderly carers	Sweden
	Semi structured interviews (qualitative data- gathering)	15	15 – native-born elderly carers	
(Da Roit, van Bochove, 2017)	Semi structured interviews (conversations)	-	5 – agencies	Holland
(Schwiter et al., 2018)	Case study		Analysis and comparing of life in care schemes in UK, Canada, Austria, Switzerland	UK, Canada, Austria, Switzerland
	In-depth interviews	Number of respondents was not reported	80 – care workers, care receptients and their family members, representatives of care	

			agencies, activists, academic experts 10 – NGO's,	
(Adhikari, Melia, 2015)	In-depth interviews	21	-	UK
(Ranci et al., 2021)	Content analysis of articles	-	4 – national newspapers with the largest circulation in Italy (2) and UK (2)	Italy, UK
(Isaksen, 2012)	In-depth interviews	8	19 – migrants' family members	Norway
(Farris, Marchetti, 2017)	Overview of care arrangements	-	3 countries: UK, Sweden, Italy	UK, Sweden, Italy
(Hellgren, 2015)	In-depth interviews	19	32 – NGO, church, policy makers, companies, spokespersons of employers, trade unions representatives	Spain, Sweden
(Picchi, 2016)	Comparative analysis of country context		3 countries: France, Italy, Spain	France, Italy, Spain
(Doyle, Timonen, 2009)	In-depth interviews	40	-	Ireland
(Figueiredo et al., 2018)	In-depth interviews	226	456 - native-born domestic and elderly carers	Portugal
(Schmidt et al., 2016)	In-depth interviews	9	5 – brokering agencies 3 – public officials involved in implementing new law	Austria
(Bourgeault et al., 2010)	In-depth interviews	19	-	Canada
(Bastia, 2015)	Life story interviews	19	-	Spain
(Hussein et al., 2013)	In-depth interviews	96	-	England
(Leiber et al., 2021)	In-depth interviews	-	143 – brokering agencies	Austria, Germany
(Pandey et al., 2021)	observations	-	analyzes of 16 meeting of ca. 2 hours	United States
(Lutz, 2002)	Literature review	-	-	-
(Shamir, 2013)	Case study	-	State law and policy in Israel	Israel
(Huang et al., 2012)	Questionnaire surveys	162	162 – employoyers 998 – employers Ca. 20 – recruiting agencies Ca. 20 – nursing home operators, hospitals with geriatric departments, representatives of relevant ministries, NGOs, professional nursing bodies, healthcare worker recruitment agencies	Singapore
	In-depth interviews	43		

(Salami, Meherali, 2018)	Semi structured interviews	15	-	Canada
(Casanova et al., 2020)	Review of literature		28 records	Italy
	Face-to-face interview	-	5 – experts from universities, national research institution, care providers association	
(Bruquetas-Callejo, 2020)	Semi structured interviews	10	34 – family carers, municipal officers, labour inspectorate, healthcare inspectorate, migrant associations	The Netherlands
	Telephonic survey		10 – employment agencies	
(Cohen-Mansfield et al., 2019)	In-depth interviews	98	111 – family members 61 – older persons	Israel
(Chau, 2019)	In-depth interviews	13	20 – representatives of care agencies	Switzerland
(Giordano, 2021)	In-depth interviews	26	-	Belgium
	Focus group	1		
	Fieldwork notes	not reported		
	Whatsapp, SMS	not reported		
(Ortiga et al., 2021)	In-depth interviews	-	9 – caregiver trainers 28 – placement agents	Singapore
	Review of newspaper articles	-	244 – newspaper articles	
(Iecovich, 2011)	Questionnaire, face to face interviews	335	335 care recipients (the sample included dyads of care recipients and their migrant care worker)	Israel
(Palenga-Mollenbeck, 2013)	Narrative-biographical interviews	22	41 – migrants' family members	Germany
	Media discourses	-	not reported	
(Nowicka et al., 2021)	Interviews	-	28 representatives of sending agencies 10 experts	Germany
(Simonazzi, 2009)	Comperative analysis	-	European country models of elderly care	EU countries
(Ayalon, 2021)	Literature review	-	not reported	-
(Liew et al., 2020)	In-depth and „go-along” interviews	35	69 care recipients	Singapore
(Martin-Matthews et al., 2010)	Interviews	81	37 – native born carers	Canada
(Shutes, Chiatti, 2012)	Postal/Online survey		557 – providers of elderly care	Italy, UK
	Semi structured telephone interviews		30 providers of elderly care	
	In-depth interviews	39		
	Face-to-face survey	220	990 family carers	
(Elrick, Lewandowska, 2008)	Biographical narrative interviews	25	-	Germany, Italy
	Conversations with key informants	-	Mayors, priests, school directors	
(Da Roit, Weicht, 2013)	Fuzzy-set analysis	-	Nine country comparison	Netherland, France,

				Sweden, Norway, UK, Austria, Germany, Italy, Spain
(Palenga-Möllenbeck, 2013)	Narrative-biographical interviews	22	41 – family members	Poland, Ukraine, Germany
	Media discourses	-	not reported	
(van Hooren, 2012)	Case studies	-	Italy Netherlands and England	Italy, the Netherlands, England
	Expert interviews	-	Representatives of trade unions, migrants organizations, providers organizations, policy makers	
	Phone interviews	-	Selected care providers in Amsterdam	
(Lan, 2018)	Desk research	-	Government documents, policy reports, journalistic coverage, secondary literature	Japan
	In-depth interviews	2	Agency staffer	
	Observation	-	Training seminar for instructors	
(Lyberaki, 2011)	Desk research	-	Statistics, policy documents, literature	Greece
(Di Rosa et al., 2012)	Face-to-face interviews	220	990 families of older people	Italy
(Lovelock, Martin, 2016)	Face-to-face interviews	29	-	New Zealand
(Gozdziak, 2016)	Ethnographic, in-depth interviews	not reported	Helthcare administrators	Poland
	Participative observations	-	Care centre	
(Della Puppa, 2012)	In-depth interviews	15	-	Italy
(Hrženjak, 2013)	Semi-structured interviews	29	-	Slovenia

Source: Own elaborations.



## ANALYSIS OF THE DEVELOPMENT OF MEANS OF TRANSPORT IN LARGE METROPOLIS – A CASE OF KRAKOW

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**Purpose:** The purpose of this paper is to assess the use of transport on the example of the city of Krakow.

**Design/methodology/approach:** The article uses the following methods to achieve the set goal: literature analysis, descriptive and statistical analysis of data obtained in primary research carried out by the authors using the observational method.

**Findings:** The process of developing means of transport depends, among others, on: on the city's transport policy and residents' awareness of sustainable development. Each studied street had a means of transport that could be considered dominant on it. In total, the majority of passenger cars were recorded on all streets, followed by pedestrian traffic. It can also be noticed that the traffic of individual means of transport in Krakow is not even. This applies especially to car traffic.

**Practical implications:** When planning the organization of transport in the city, it should be taken into account that the traffic of individual means of transport in Krakow is not uniform and the fact that there are communication routes running through the city that are specifically used by a given type of vehicles. This applies to both public transport vehicles that operate only on designated routes and private vehicles. When designing changes in infrastructure, it is also necessary to take into account the expectations of groups using different means of transport and to ensure the possibility of quick travel, among others thanks to Intelligent Transport Systems.

**Originality/value:** The article provides insight into the way transport is used in various parts of the city of Krakow. This will allow for the development of changes in the city's transport infrastructure allowing for better use of public transport, which will contribute to environmental protection, reduce traffic intensity in Krakow and increase residents' awareness of sustainable development.

**Keywords:** transport, road traffic, means of road transport.

**Category of the paper:** Research paper.

## 1. Introduction

Moving shorter and longer distances has been an integral part of people's lives since the beginning of time. Over the centuries, methods to make traveling easier have been improved. Currently, there are many options for moving around the city (Wiktorowska-Jasik, 2016). The choice of means of transport depends on the distance, costs and time you want to spend, the luggage you want to transport, your physical condition and the driving comfort you want to achieve. Ease of movement is one of the important factors in assessing the quality of life. The current development of technology and globalization means that transport is subject to constant changes. Solutions used in the design and production of means of transport, as well as in the organization and construction of transport infrastructure, must meet the requirements of modern people. Each city is characterized by its own spatial layout, which is usually subject to constant changes. Krakow covers an area of 327 km<sup>2</sup>, but including the entire agglomeration it covers approximately 3200 km<sup>2</sup>, which is almost 10 times larger. The span of Krakow from north to south is 18 km and from west to east 31 km. According to „Krakow in numbers 2022”, the total length of the street and road network in Krakow was 1110.2 km. The bicycle paths had a total length of 176 km. There were 28 tram lines with a total length of 365 km and 181 bus lines with a total length of 2,394 km in Krakow. According to MPK S.A. estimates in 2022 it carried 220 million passengers. There were 665,881 vehicles registered, including 531,209 passenger cars. This means that 852.6 vehicles were registered per 1,000 inhabitants, including 680.2 passenger cars. The Krakow authorities, through their policy, want to reduce car traffic in favor of bicycle traffic and public transport (<https://www.bip.krakow.pl/zalaczniki/dokumenty/n/424929/karta>). The Main Market Square is similar in shape to a square with sides of 200 m. Eleven streets radiate from it. The historic city center is surrounded by 4 ring roads: I, II, III and IV. The first ring road runs through streets where, on many sections, traffic is limited to one direction. Only public transport and service vehicles can move in the other direction. The aim is to eliminate car traffic from the city center and thus make the area more pedestrian-friendly. The second bypass is closed and fully passable. The third ring road is not completely finished. Some of them are in construction plans, and some are under construction (Trasa Łagiewnicka). Therefore, it is not yet passable along its entire length. The fourth ring road is also not completely completed. It will have a total length of 60 km. Ultimately, it will surround Krakow, and its route will include 18 road junctions, where you will be able to access individual districts or towns ([https://pl.wikipedia.org/wiki/Obwodnice\\_Krakowa](https://pl.wikipedia.org/wiki/Obwodnice_Krakowa)).

## 2. Literature review

The implemented transport policy in cities determines the development of transport in these areas. If this policy is consistent with the idea of sustainable development, it is able to increase the quality of life. Sustainable development is a model of harmonization of social, economic and environmental systems (Kryk, 2003; Misztal, 2022). The goal of sustainable development is to use natural resources and organize social life in such a way as to maintain a high quality of life (Costa, 2022; Sun et al., 2023). The quality of life in cities where passenger cars dominate urban travel is much worse than in cities where the so-called clean transport. The use of cars by city residents causes excess exhaust fumes and noise, and they live in traffic congestion conditions (Petelewicz et al., 2016). An example is the city of Krakow, where there is still too little social awareness in the field of sustainable transport, which results in Krakow's situation still among the most polluted European cities. The motorization rate expressed in the number of cars per 1000 inhabitants in Poland increased two to three times in the years 1999-2016 (Wyszowski, 2017).

The idea of sustainable development focuses on the future of electric buses, electric and autonomous cars, and the shared use of passenger cars in the light of the so-called sharing economy and cycling as a means of urban transport. The structure of urban travel is still dominated by passenger cars (Grzelec et al., 2017; Witkowski, 2023). The policy of sustainable transport development in cities should therefore aim to provide residents with a satisfactory quality of life, which is considered the most important resource determining the city's development, and to achieve a competitive advantage by attracting new capital to the city and new residents (Wyszowski, 2011). To talk about sustainable transport, it is necessary to assume coexistence of implementation environmental values, society's needs and economic goals. When attempting to introduce modern means of transport, it is necessary to apply the smart administration and smart city philosophy, based on access to modern information and communication technologies and the creation of sustainable transport systems of a diverse nature (Mielczarek-Mikołajów, 2021). The transport sector is included in the smart city concept because with its development, all departments of the national economy function effectively and efficiently (Bryk et al., 2021). It is also an extremely important area for sustainable development due to its social and economic benefits (Jać et al., 2015). You can't talk about a smart city without mentioning the applications used en masse in urban transport. One mobile transportation app can meet most needs in the transportation industry, from ridesharing to GPS location, route planning, navigation to data collection and analysis of traffic conditions for advice on when to travel (Nowotarska-Romaniak, Szczepanik, 2023).

Research on the implementation of mobile technology in the Polish public transport system has already been carried out. A review of information technologies supporting traveling by public transport in Poland and Germany was carried out, defining the basic features and

functions of the systems operating in the analyzed years (Bojda, 2011). Several studies analyzed the introduction of passenger information into the mobile system in various Polish cities. The research concerned cities such as Radom (Grad et al., 2013), Krakow (Kędzior, Bryniarska, 2015; Bryniarska, Gacek, 2018), Upper Silesian Industrial District (Kos, 2016; Bartnicki, 2023) and Lublin (Berlińska, Choma, 2018). The aim of the study in Krakow was to assess the level of passenger information based on the opinions of public transport users. Passengers assessed the quality of information available during the trip at the planning stage, at stops and in vehicles (Nowotarska-Romaniak, Szczepanik, 2023). Research was also carried out in Krakow (Bryniarska, Gacek, 2018) aimed at characterizing and assessing travel planners in terms of their usefulness for public transport passengers in the city. This study showed the extent to which websites and mobile applications are used and what information they contain is the most important, valuable and helpful. Sustainable transport must take into account the availability of transport services in accordance with the requirements of health and ecological safety, it must be consistent with the principle of intergenerational justice, with appropriate land use, and with the need to reduce noise. Its aim is to improve the standard of living and safety, promote public transport and take into account the needs of pedestrian road users (Piaseczny, 2016). In accordance with the policy of sustainable development, the development of public transport in cities must shape transport offers based on the results of research on current transport preferences potential passengers; use ecological means of transport using electric drive; provide public transport with priority in road traffic, e.g. by separating traffic lanes, buses powered by combustion engines should be replaced with electric buses (Hebel, 2017). Sustainable transport is the answer to failed policy transport that took place in the second half of the 20th century. The concept of sustainable transport is the basis for a number of activities of European Union bodies. There is a so-called White Paper of 28 March 2011 announcing the creation of a single European transport area while ensuring the reduction of gas emissions greenhouses. This will support ecology. It should be added that assumptions regarding sustainable transport are adopted at the EU and national levels, including at the local level (Mielczarek-Mikołajów, 2021, Biała Księga, 2011).

In order for sustainable transport to develop, public authorities should focus on reducing pollution, exhaust fumes and car traffic, minimizing noise, developing public transport, which can be achieved by creating effective public transport, as well as ensuring safety in transport or promoting alternative forms of transport such as bicycles and others (Sobol, 2017). A good alternative to public transport is the possibility of renting city bikes or electric scooters (Korneć, 2018). The concept of the so-called Car-sharing, i.e. a short-term car rental system. In Poland, this system has been operating since 2015. The first cities to introduce car-sharing include Warsaw and Wrocław. Over time, they were also introduced in other cities (Pawłowska, 2017). In Krakow, private entities have been engaged in this type of activity, e.g. Traficar. When designing infrastructure transport for the city, it should be borne in mind that travelers choose travel routes mainly due to their own criteria optimization. Most often, these are: travel

time, travel comfort, and costs. Simultaneously urban development is quite dense and, especially in cities with a long history, not adapted to modern means of transport and the multitude of journeys. Therefore when designing the layout, on the one hand, needs should be taken into account as much as possible residents and visitors, and on the other hand, carefully analyze the restrictions resulting from development, current technical possibilities and available finances (Misztal, 2023). In relation to large metropolises, which is undoubtedly Krakow, a good solution seems to be electric scooters and UTO personal transport devices, i.e. electrically powered vehicles, e.g. an electric skateboard, an electric unicycle or a Segway without a seat or pedals, designed to be moved only by the driver in the driver's seat on this vehicle. To rent electric scooters, it is also necessary to have an application (He et al., 2021). In May 2021, changes to the Act of June 20, 1997, Road Traffic Law (Journal of Laws of 2021, item 450) came into force, which specify what it is and how the above-mentioned persons can move. vehicles. The road law also addressed devices powered by muscle power and adapted to move in a standing position, called movement-assisting devices (UWR). These include: roller skates, roller skates, skateboards, traditional scooters (<https://www.gov.pl/web/infrastruktura/nowe-przepisy-dotyczace-hulajnog-elektrycznych-i-urzadzen-transportu-osobistego2>).

Another solution in urban transport is first and last mile transport. This is the first and last stage of the journey. This may apply to both the transport of people and goods (<http://www.gios.gov.pl/pl/eea/aktualnosci/produkty/658-zrownowatyny-transport-wmiastach>). Within in the last decade, with the development of technology, the number of online purchases has increased. This trend was also intensified by the pandemic, where access to stores was limited. In the transport of goods, the last mile is the delivery of the shipment to the final recipient - home or another agreed place. Parcel lockers make things easier, where parcels are left for many customers who collect the parcel at a set time (Wierzbicka, 2023). First-mile passenger transport is the delivery of a passenger from the starting point to a transfer point (where there are larger passenger flows), and last-mile transport is the delivery from the transfer point to the destination point (Niekurzak, Kubińska-Jabcoń, 2022). The construction of a Fast Agglomeration Railway, metro or tram is profitable in the case of large passenger flows. However, it should be remembered that people live several kilometers away from the stops of such means of transport. To use this mode of transport, they must cover the distance from their home to the bus stop. They can do it done on foot, by bike, by car, by another form of public transport, etc. This means the need to build appropriate infrastructure, such as parking lots or public transport (Byliko, 2023). Due to short routes and usually low population density, the vehicle does not have to accommodate many passengers or reach high speeds. However, it should travel frequently and stop close to the passengers' place of residence (Ochojski, 2022). An example of a vehicle that meets the criteria for first and last mile transport is the Navya Arma. It is currently in the testing phase. It has been produced since 2015 and can accommodate 15 passengers (including 11 in seats) (Niekurzak, Kubińska-Jabcoń, 2021). It reaches speeds of up to 45 km/h. It uses an electric drive and has a low floor. An example of a district designed to minimize car traffic is Seestadt Aspern in Vienna. A road runs through it, which constitutes

a "bypass" of the district center and leads traffic outside. Tested there are Navya vehicles. In addition to communicating with traffic lights (which allows priority to be given at public transport intersections) and detecting pedestrians and cyclists, the vehicles warn other autonomous vehicles about dangers. Work on sensors and communication was undertaken by Siemens. C2X technology was used, i.e. a road traffic management system that ensures communication between vehicles, infrastructure and traffic control centers. Vehicles receive data almost in real time, and on-board components (OBU) provide the vehicle's position, speed and direction (Tomaszewska, Florea, 2018).

Another effective solution in urban transport is the metro. The main goal of building the metro is to improve traffic by transporting a large number of passengers on a route that has no intersections and can therefore cover distances faster than on the surface. Ground traffic is also not interrupted by the metro (Witlowski, 2012). It is used in large cities with large passenger flows (Janczewski, Janczewska, 2021). Plans to build the first metro tunnel appeared already in the 1960s in the „Local Spatial Development Plan of Krakow". Various options were taken into account when developing the optimal solution, including: fast tram, metro, premetro) and these solutions were analyzed in 5-year time frames from 2028 to 2058. Taking into account financial, social and functional factors, one variant was chosen. On June 7, 2021, the "Feasibility study for a fast, collision-free rail transport in Krakow. The latest study assumes the construction of a pre-metro line that will be 21.82 km long and will have 32 stops along its route. It is to connect Jasnogórska Street with Wzgórza Krzesławickie. It will not be a metro as defined, but a tram that will quickly move from one part of the city to another. For this purpose, it is planned to build a 6.6 km long tunnel and a 1.4 km flyover. Therefore, it will be underground-ground-above-ground urban transport. The entire construction is to be completed in 2037, but the first sections are to be put into operation in 2033 (<https://www.transport-publiczny.pl/wiadomosci/krakow-bedzie-mial-premetro-wyniki-studium-69116.htm>).

Autonomous transport capsules are one of the most modern forms of transport. They move without a driver. The most famous ones are located at Heathrow Airport in London. They are an alternative to traditional buses. They can accommodate 4 people with luggage. They arrive at the terminals approximately every 1 minute and connect 5 terminals and a parking lot (El-Sherif, 2021). After passengers enter the vehicle, simply select their destination (terminal number or parking lot) on the touch screen. The automatic transport capsule will find the route and take passengers to their destination on average several times faster than a traditional bus. The capsules are computer-controlled, it is not possible to change their direction. For them, a viaduct was built connecting the parking lot with the terminal. The routes are repeatable, but depending on the selected destination, the capsule goes to a given place (Appio et al., 2019). The whole thing is specially prepared and is approximately 4 km long. The vehicle can reach speeds of up to 40 km/h. Such devices work well in confined spaces, such as airports, but it would be much more difficult and expensive to introduce them to general use in cities (<https://podroze.se.pl/aktualnosci/automatyczne-kapsuly-transportowe-na-heathrow-lotn/1578>).

### 3. Research methodology

For the purposes of this paper, the observational method was used. The observational method is a scientific procedure in which the occurrence of observable behaviors is revealed. These behaviors are organized and analyzed, both qualitatively and quantitatively, through the use of instruments and parameters that allow the detection of relationships between them (Anguera, Hernández, 2014). Their goal was to observe how the traffic of pedestrians and individual types of vehicles in the city is distributed depending on legal restrictions, as well as the distance from the center and other characteristic features. It is also helpful in developing urban infrastructure that takes into account the needs of residents. Eight points in the city were selected for the study. These are cross-sections of the streets: św. Tomasza, Szewska, Dunajewskiego, Karmelicka, Aleja Mickiewicza, Nawojka, Piastowska, Rajska. Two of them are located inside the 1st ring road (St. Tomasza - has no points in common with the Main Square, Szewska - has a point in common with the Main Square), two between the 1st and 2nd ring roads (Karmelicka - is an extension of Szewska Street leading directly from the Market Square, Rajska - is perpendicular to Karmelicka Street), two between the 2nd and 3rd ring roads (Nawojki - is an exit street from the city center towards the west, Piastowska - is perpendicular to Nawojki Street), one on the 1st ring road (Dunajewskiego) and one on the 2nd ring road (Aleja Mickiewicza). All points are located west and north-west of the Main Square. The research was carried out for 1 hour outside the early morning and afternoon peak, i.e. between 10 a.m. and 1 p.m., and for 1 hour during the afternoon peak, i.e. between 3 and 6 p.m. The following terms were introduced in the work: "morning" meaning the examination between 10 a.m. and 1 p.m. and "afternoon" defining the examination between 3 and 6 p.m. The test was not carried out in weather conditions that were significantly different from those in other tests. In practice, it was sunny during the research cloudy, but warm and no rain. It should be noted that during the study, some solutions previously used in connection with the Covid-19 pandemic remained, therefore a large group of people worked remotely, which also had an impact on traffic on the city streets (Olkiewicz, 2023). The research was carried out in May because it is not a month when many people go on holiday, and on the other hand, tourists are slowly starting to come to Krakow (Niekurzak, Kubińska-Jabcoń, 2021) and (Kubińska-Jabcoń, Niekurzak et al., 2022). The weather in May encourages the use of alternative means of transport, e.g. electric scooters, mobility devices or bicycles. It should be noted that the aim of the study was not to count all people moving on a given street, but only vehicles. Therefore, when implementing the test results, it should be taken into account that there may be 2 or more people in/on the vehicles. According to the information posted on the website of the Public Transport Authority in Krakow, the number seats in buses range from 16 to 45. Due to incomplete occupancy, it was assumed that on average 75% of the seats in the bus are occupied, which, rounded up to the nearest unit, is 25 occupied seats. A similar approach

was adopted in trams. Data for calculations were taken from the website of the Public Transport Authority in Krakow (<http://kmkrakow.pl/informacje-o-systemie-kmk/tabor-naczkow-operatorow.html>).

An average of 75% of the seats occupied, rounded up to one, gives 40 people. The study assumed that the bus transports an average of 17 people - the average of the minimum and maximum number of people in the vehicle. The average number of people in a coach was 38 - one of the most popular carriers has coaches with 51 seats, while the minimum number of people is 24. The arithmetic mean of these two numbers was taken and the result was rounded to unity. Based on research published in "The Concept of Integration of Transport Systems in the Krakow Functional Area" the average passenger car capacity is 1.3 people (<http://metropoliakrakowska.pl/wp-content/uploads/2019/01/Koncepcja-integracji-system%C3%B3wtransportowych-KrOF.pdf>).

In this work, the coefficient was related to passenger cars, as well as taxis and cars used in car-sharing. Law enforcement cars usually carry two people, e.g. a patrol, which is why the value 2 was adopted at work. Motorcyclists usually ride alone, but there are also passengers. The coefficient was assumed to be 1.1, which means that every 10th motorcycle carries a passenger. A coefficient of 1 was assumed for a bicycle. Low-speed vehicles have very different capacities. Some routes are operated only by drivers without passengers. It was assumed that on average there are 6 people in a slow-moving vehicle at the same time. The main aim of the research was not to present the share of all moving people in traffic, but only the structure of means of transport. Hence the coefficients  $w$  adopted in this work. Depending on the season, time of day, and the detail of the analysis performed, they may change. The research included the following means of transport and forms of movement: a) pedestrians - this group included people walking, running, riding in a stroller or wheelchair, carried on their hands, as well as using ride-on bikes and push-bikes for children, b) bicycle - for This group includes "vehicles with a width not exceeding 0.9 m, moved by the muscles of the person driving the vehicle". This group includes both traditional vehicles and those with an electric engine (so-called electric bicycles). The age of the person driving the vehicle was not taken into account, c) passenger car - this group does not include vehicles classified into other categories, in particular the group of taxis and cars used in car-sharing, delivery cars and law enforcement and municipal services, d) taxi and cars used in car-sharing - for the purposes of the study it was assumed that this was a car passenger car used to transport people (max. 8) for commercial purposes. These cars were recognized based on the inscriptions placed on the side of the vehicle and on the roof. The purpose of separating these vehicles was to examine how many vehicles are not used by one household, but are used by more people. This use of vehicles contributes to an increase in free parking spaces and is also one of the elements of the transport policy aimed at limiting the number of combustion vehicles registered in the city.



It should be noted that vehicles used in car sharing are the property of companies, e.g. Traficar, and the research does not include unmarked vehicles that, for example, a group of friends borrow from each other. Such a solution is currently so rare in Krakow that it can be omitted. During the research, it was observed that taxis are used much more often on the streets of Krakow than cars used in car-sharing, e) commercial vehicle - according to the Road Traffic Law, a heavy goods vehicle is „a motor vehicle designed to transport loads; this term also includes a truck and passenger car designed to transport loads and 4 to 9 people, including the driver” (Act of June 20, 1997, Road Traffic Law (Journal of Laws of 2021, item 450)). For the purposes of the research, it was assumed that the main purpose of using a delivery vehicle is to transport cargo. Due to the fact that some vehicles are used both for the purpose of transporting people and goods, the research may raise some doubts whether a given vehicle should be classified as a passenger car or a commercial vehicle. The criterion according to which the division was made was whether the vehicle was used mainly to transport people or goods. Membership in a given group was determined by the way the vehicle was marked on the body, the size of the vehicle, and possibly what was inside and on the vehicle. This is the most diverse group because it includes both relatively small vehicles, e.g. used to transport valuables and cash, and trucks. However, the aim of the study was not to focus on this group of vehicles, therefore, if there was greater interest in this group, the research should be repeated taking into account the appropriate subcategories. This group does not include vehicles of security and municipal services, f) bus - a vehicle used to transport people for commercial purposes on fixed routes, with at least 10 seats including the driver, and a maximum of 23 seats, g) coach - a vehicle used to transport people for commercial purposes on fixed routes, with a minimum of 24 seats, h) public transport bus - this group included both vehicles operating on their routes , as well as technical crossings, exit to the route and exit to the depot, i) tram - „a vehicle intended for the transport of persons or goods powered by electricity, moving on rails on public roads” (Act of June 20, 1997, Traffic Law road (Journal of Laws 2021, item 450). The study included both trams running on fixed routes and technical crossings, j) security and municipal services - this group included all municipal, uniformed and security services, regardless of the vehicle they used. These included both passenger cars and large vehicles, e.g. used for garbage collection, k) electric scooters, i.e. electrically powered vehicles, two-axle, with a steering wheel, without a seat and pedals, designed to be moved only by the driver on this vehicle, l) personal transport equipment (UTO) - „electrically powered vehicles, excluding electric scooters, without a seat and pedals, structurally intended for movement only by the driver on this vehicle” (Act of June 20, 1997, Road Traffic Law, Journal of Laws of 2021, item 450). This includes: electric skateboard or Segway, m) device supporting movement - these are "sports and recreation devices or equipment intended for the movement of a person in a standing position, powered by muscle power" (Act of June 20, 1997, Road Traffic Law, Journal of Laws of 2021 r., item 450). These include: skateboards, scooters and roller skates, n) motorcycles and mopeds - a motorcycle is a „two-wheeled motor vehicle of the L3e category or a two-wheeled

vehicle with a sidecar of the L4e category or a three-wheeled vehicle of the L5e category with symmetrical arrangement of wheels, while a moped is „a two- or three-wheeled vehicle equipped with an internal combustion engine with a cylinder capacity not exceeding 50 cm<sup>3</sup> or with an electric motor with a power not exceeding 4 kW, the design of which limits the driving speed to 45 km/h" (Act of June 20 1997 Road Traffic Law, Journal of Laws of 2021, item 450), o) low-speed vehicle - a motor vehicle whose design limits the driving speed to 25 km/h, excluding an agricultural tractor (Mikulik, Niekurzak, 2023). All low-speed vehicles that were observed during the study are popularly called melexes and are mainly used for transport for tourist purposes. In this work, the phrase „means of transport" is used to cover all forms of transport mentioned in the article.

#### 4. Results and discussion

Results obtained at ul. Saint Thomas 9, where there are several popular eating places nearby, concerned people going to these establishments, as well as people who deliver food from restaurants on bicycles. Therefore, it should be assumed that pedestrian and bicycle traffic is not exclusively through traffic on this section. This is the street inside the first one the ring road, where entry is prohibited, except from 8 p.m. to 9:30 a.m only for the duration of cargo operations, money convoy and service technical, bicycles, special services, municipal services, horse-drawn carriages, special convoy to the bank, with the permission of the road authority. Movement of residents and taxis are allowed. On the street of St. Thomas is a paid parking zone. The survey was conducted on May 31, 2025, between 11:53 and 12:53 and from 15:25-16:25. Morning and afternoon traffic on the street Saint Thomas (Table 1).

**Table 1.**

*Morning and afternoon traffic on Saint Thomas Street - own study based on Bazior A.*

Mode of transportation	Test time	
	Morning	Afternoon
walking	220	332
bicycle	9	21
car	24	16
Taxi	4	2
truck	4	6
enforcement services	1	0
electric scooter	0	1
movement assist device	0	1
motorcycle, moped	3	1
<b>Sum</b>	<b>265</b>	<b>380</b>

Pedestrian traffic has by far the largest share in traffic – over 80% of all traffic. This is due to legal restrictions on cars driving around the center. In the afternoon, pedestrian traffic was approximately 50% higher than in the morning. Afternoon cycling more than twice as many were recorded. However, the number of passenger cars was greater in the morning – 50% more than in the afternoon. In total, no cars passed however, a lot - on average, a passenger car passed once every 3 minutes. The rest too few means of transport have been observed to draw conclusions so far passing them. Below are the results obtained at ul. Szewska, where traffic is prohibited in both directions, except for bicycles, which can move on it in both directions sites 24 hours a day. In the direction from Jagiellońska Street to ul. Dunajewski they can Special and municipal services also move around, arriving at the property or garage and with the permission of the road authority. It is allowed from 8 p.m. to 9:30 a.m entry servicing institutions and shops located in this area. People's vehicles disabled people can enter only between 6 a.m. and 12 p.m. In accordance with with signs, it is a residential zone, so pedestrians can move around the entire area street width. Observation was carried out in the morning from 11:10 to 12:10, and in the afternoon from 15:10 to 16:10. Both tests were carried out on May 25, 2023. Morning and afternoon traffic on ul. Szewska (Table 2).

**Table 2.**

*Morning and afternoon traffic on the street Szewska – own study based on Bazior A.*

Mode of transportation	Test time	
	Morning	Afternoon
walking	939	1078
bicycle	119	143
car	1	0
truck	1	0
enforcement services	6	2
electric scooter	11	7
movement assist device	1	2
<b>Sum</b>	<b>1074</b>	<b>1232</b>

Pedestrians have the largest share of traffic. Both in the morning and in the afternoon it is he over 87%. In second place are bicycles, which constitute approximately 11% of the total traffic. All motor vehicles constitute a marginal share of traffic and are used almost exclusively by municipal services, e.g. cleaning. There are more of them in the early morning hours. This is a popular street for people who want to take a shortcut through the Main Market Square, as well as tourists and people who want to relax after work or school. You can often meet groups of several young people heading towards one place from many eating places in this area. Due to limited vehicle traffic mechanical, you could meet people working on renovations who carried all the necessary renovation equipment with them. This is unusual in other locations where delivery vehicles of renovation and construction teams are found. Results obtained at ul. Dunajewskiego 3 were obtained taking into account that it is valid speed limit to 30 km/h. Passenger cars can move in one direction towards Karmelicka Street, while buses, trams, bicycles, police and City Guard - in both directions. Dunajewskiego Street is in a restricted

traffic zone. Behind Matejki Square, i.e. before Basztowa Street, there is an entry prohibition sign, which does not apply to vehicles with a type K parking subscription for sectors A1, A2, A3, A4, from 6-10 p.m. and 1-2 p.m. only for and on time. carrying out loading operations and technical service, with an electric engine without trailers, bicycles, horse-drawn carriages, taxis, CC, CD, UTO and electric scooters, special services, marked medical assistance, commuting to the property, garage or purchased reserved space, KMK, on time of RTV transmissions, with mail, transporting money to banks in zones A and B, with the permission of the road authority and municipal services. The study was conducted on May 25, 2023, from 10:05 a.m. to 11:05 a.m. and on May 26 2023 from 15:50 to 16:50. Due to the fact that the pedestrian and bicycle route runs parallel to the street through Planty, therefore, the study was carried out both on the cross-section of the street and on the appropriate section of Planty. Morning and afternoon traffic on the street Dunajewski (Table 3).

**Table 3.**

*Morning and afternoon traffic on the street. Dunajewski's division into Planty and the street - own study based on Bazior A.*

Mode of transportation	Test time			
	Morning		Afternoon	
	Street	Plants	Street	Plants
walking	176	173	373	569
bicycle	31	45	119	207
car	131	0	155	0
Taxi	04	0	72	0
truck	35	0	20	0
autobus KKM	22	0	26	0
tram	65	0	67	0
movement assist device	22	0	7	0
electric scooter	1	5	10	26
movement assist device	0	1	2	28
motorcycle, moped	7	0	20	0
slow-running vehicle	2	0	5	0
<b>Sum</b>	<b>586</b>	<b>224</b>	<b>876</b>	<b>830</b>

Traffic on the street Dunajewskiego is more diversified than inside the 1st ring road. Pedestrians constitute 43% of traffic in the morning hours, and bicycles constitute over 9% of traffic. In the afternoon, pedestrians account for approximately 55% of traffic, and bicycles account for approximately 19%. You can observed a more than twofold increase in the number of pedestrians and a more than fourfold increase number of cyclists in the afternoon compared to the morning. The traffic of electric scooters, mobility devices and motorcycles is also greater in the afternoon. The city's transport policy aims to limit car traffic and therefore the first ring road is not two-way along its entire length. Road signs are also erected ordering driving in the direction "from the Market Square". In the morning, a larger number of law enforcement vehicles and delivery vehicles were observed. The differences between the traffic of private passenger cars and taxis are not large. Almost all car traffic goes towards ul. Karmelicka. Public transport is average every 40 seconds. This transport is organized by the Municipality

of Kraków. NO movement of private buses and coaches was observed. Results obtained at ul. Karmelicka 50, which connects the first and second ring roads and has one lane in each direction, which are not separated from each other, are presented below. The tram track is not separated. This means that all combustion vehicles, trams and bicycles have one lane in each from the pages. The speed limit is 30 km/h. The survey was conducted on May 24, 2023, from 10:25 a.m. to 11:25 a.m. and on May 26, 2023, from 5:07 p.m. to 6:07 p.m. Morning and afternoon traffic on the street Karmelicka (Table 4).

**Table 4.**

*Morning and afternoon traffic on the street Szewska – own study based on Bazior A.*

Mode of transportation	Test time	
	Morning	Afternoon
walking	658	895
bicycle	85	199
car	205	178
Taxi	82	68
truck	40	8
autocar	1	0
tram	49	57
enforcement services	14	4
electric scooter	7	15
movement assist device	0	5
motorcycle, moped	11	10
<b>Sum</b>	<b>1152</b>	<b>1439</b>

In the afternoon, ul. More than 30% more pedestrians crossed Karmelicka and more than twice as many bikes as in the morning. More passed through in the morning delivery vans (up to 5 times), taxis (by approx. 20%) and cars personal services (by approx. 15%) and security services (3.5 times more). Cars delivery vans are largely dependent on individual working hours enterprises. An interesting observation is a small difference in the number of passenger cars depending on the time of day, and even a smaller number in the afternoon (by approximately 14%). There were 3.5 times more law enforcement cars in the morning than in the afternoon, and more than twice as many electric scooters. Movement aids only appeared in the afternoon. Public transport vehicles mainly include trams. In addition, there was one coach from a private company. 16% more trams passed in the afternoon than before noon. This is due to the timetable, because during rush hours there are trams and buses usually run more frequently. Based on the study conducted, it is impossible to determine the difference in the number of motorcycles, because the difference shown is not statistically significant. The results obtained on Adam Mickiewicza Avenue were carried out at pedestrian crossing connecting Krakowski Park with ul. Kochanowski with a shift towards the intersection with ul. Czarnowiejska. There is no pedestrian crossing traffic lights. The avenues have 3 separated traffic lanes in each direction green belt. The speed limit is 50 km/h. Rightmost lane on each side constitutes the so-called bus lane intended only for buses, coaches, buses, taxis, police, City Guard, motorcycles, ambulances, municipal Transport of Disabled Persons. There is a sidewalk on the

Old Town side, while on the Krowodrza side there is a very narrow, practically unused sidewalk. However, it should be noted that from Plac Inwalidów to ul. Czarnowiejska along Aleja is located Krakowski Park. The alley running along Mickiewicz Avenue serves as a route walking and cycling. In the study, it was treated as part of the Avenue. There was a test conducted on May 24, 2023 at 11:24-12:24. The afternoon examination was also conducted on May 24, 2023, from 4:00 p.m. to 5:00 p.m. Morning and afternoon traffic on al. Mickiewicz divided into the direction of vehicle traffic (table 5). Table 5 does not include pedestrians, bicycles, electric scooters and movement support devices.

**Table 5.**

*Morning and afternoon traffic on al. Mickiewicz's division into the direction of vehicle movement - own study based on Bazior A.*

Mode of transportation	Test time			
	rano w stronę		Popołudniu w stronę	
	Czarnowiejskiej	Placu Inwalidów	Czarnowiejskiej	Placu Inwalidów
car	1194	1164	1106	1174
Taxi	70	122	66	80
truck	107	155	74	87
bus	52	49	53	48
autokar	6	12	11	8
autobus KKM	41	37	55	50
enforcement services	19	15	6	9
electric scooter	21	24	31	63
slow-running vehicle	0	1	0	0
<b>Sum</b>	<b>1510</b>	<b>1579</b>	<b>1402</b>	<b>1519</b>

The number of passenger cars does not vary significantly, taking into account the direction driving or time of day. Approximately 2,300 people pass through the avenue every hour cars. Additionally, 192 taxis and so-called cars passed by in the morning. car sharing, and in the afternoon 146 such cars. This is not a significant difference. It passed before noon over 60% more delivery vehicles. This may be due to the fact that delivery to stores, and services, e.g. construction, are provided to a greater extent during working hours. It is worth paying attention to the fact that among cars delivery vehicles, only one case was a car that can be colloquially referred to as a TIR. There is no transit road through Aleje Trzech Wieszców. Through the Avenues Many public transport buses pass by, as well as private buses and coaches carriers. A bus or coach runs one way on average every minute, however public transport bus every 1.5 minutes one way. 34% more buses city buses run in the afternoon. This is related to the timetables they take into account higher traffic volume during rush hours. Security services drove over more than Twice as many in the morning than in the afternoon. This is mainly because some companies work mainly in the morning. In the afternoon, twice as many motorcycles passed through than in the morning. During 2 hours of research, 1 low-speed vehicle was observed, which means that there are also such vehicles on the Avenue, but their number is negligible number. Collective results of other means of transport divided by alley in the Park Krakowskie and on the street (table 6).

**Table 6.**

*Aleja Mickiewicza - morning and afternoon traffic on sidewalks and alleys - own study based on Bazior A.*

Mode of transportation	Test time			
	rano w stronę		Popołudniu w stronę	
	Alley In Krakow park	Outside the park on the street	Alley In Krakow park	Outside the park on the street
walking	104	42	118	58
Bicycle	53	5	121	21
electric scooter	6	2	12	2
movement assist device	0	0	8	0
<b>Sum</b>	<b>163</b>	<b>49</b>	<b>259</b>	<b>81</b>

Table 6 shows that most pedestrians, cyclists and people riding scooters move along the alley in Krakowski Park. Of course, some of them could have walked around the park and not gone to a specific destination, but considering that on this side of the Avenue, apart from the alley in the park, there is a very narrow sidewalk, they chose the alley. Moreover, the layout of the paths makes it the shortest way to walk along the Avenue. The study was conducted behind a large fork in the paths, further limiting the number of people just walking through the park. The number of pedestrians increased by 20% in the afternoon. The number of bicycles increased by 140%. This may be due to the fact that some residents use bicycles as a means of transport to and from work or university, but also use them for rides and running errands after work. The number of electric scooters almost doubled in the afternoon compared to the morning hours. Movement support devices only observed after noon. Results obtained at ul. Piastowska, which is parallel to the ring roads, were carried out between the intersection with Rolnicza Street and Cadets. In this section, the road consists of a road (one lane in both lanes). directions) and sidewalks separated by green belts on both sides of the road. The speed limit in the examined section is 50 km/h. The study was conducted by one person on May 27, 2023 at: 11:40 – 12:40 and 16:35 – 17:35. Morning and afternoon traffic on the street Piastowska (Table 7).

**Table 7.**

*Morning and afternoon traffic on the street. Piastowska – own study based on Bazior A.*

Mode of transportation	Test time	
	morning	afternoon
walking	93	155
bicycle	43	95
car	603	642
Taxi	32	28
truck	93	49
bus	1	0
autobus KKP	5	5
enforcement services	5	5
electric scooter	3	5
movement assist device	5	3
motorcycle, moped	10	14
<b>Sum</b>	<b>893</b>	<b>1001</b>

A clear difference can be observed in the number of pedestrians. In the afternoon there were them about 67% more than in the morning. More than twice as many bicycles were ridden in hours afternoons. The traffic of delivery vehicles was definitely higher in the morning, almost twice as many such vehicles passed by then than in the afternoon. Whereas in the case of passenger cars and taxis, there is no significant difference. Also no significant differences were noticed in other means of transport. Results on the street Nawojki, which is a road connecting ring road II with III, were obtained at the level of ul. Grammar 10. At this point, Nawojki Street consists of two lanes - one in each direction - not separated by greenery. There are sidewalks on both sides of the street. The study was carried out by one person on May 27, 2023, from 10:32 a.m. to 11:32 and 15:25 – 16:25. Morning and afternoon traffic on the street Nawojki (Table 8).

**Table 8**

*Morning and afternoon traffic on the street Nawojki – own study based on Bazior A.*

Mode of transportation	Test time	
	morning	afternoon
walking	245	285
bicycle	18	45
car	760	945
Taxi	53	63
truck	159	95
bus	15	12
autocar	6	5
autobus KKP	42	47
enforcement services	18	4
electric scooter	2	7
movement assist device	0	6
motorcycle, moped	8	21
<b>Sum</b>	<b>1326</b>	<b>1536</b>

Pedestrian traffic in the morning and afternoon was similar. Whereas 2.5 times more bicycles rode in the afternoon than in the morning. Number of cars passenger traffic in the afternoon was approximately 25% higher than in the morning. There were few taxis less in the morning. There were 40% fewer delivery trucks in the afternoon. In the morning definitely more - more than three times - passed by law enforcement vehicles. In turn, in the afternoon, more electric scooters and devices were observed movement aids and motorcycles. This may indicate that these means of transport residents treat it as a form of recreation or a way to get around after work, and not for everyday travel on fixed routes Rajska Street 4 connects ul. Karmelicka from ul. Dolne Młynów. Thanks to this, you can get to Aleja Trzech Wieszców. The speed limit is 30 km/h. It has one lane and a contralane for bicycles. The study was conducted on May 31, 2023, between 10:42 a.m. and 11:42 a.m. and 4:32 p.m.-5:32 p.m. Morning traffic and afternoon on ul. Rajska (Table 9).



**Table 9**

*Morning and afternoon traffic on the street Rajska – own study based on Bazior A.*

Mode of transportation	Test time	
	Morning	Afternoon
Walking	238	407
Bicycle	17	49
car	191	274
Taxi	18	18
truck	20	18
enforcement services	1	3
electric scooter	2	2
movement assist device	1	1
motorcycle, moped	10	11
Slow-running vehicle	0	1
<b>Sum</b>	<b>498</b>	<b>783</b>

In the afternoon, approximately 70% more pedestrians walked and almost three times as many crossed bicycles and 40% more passenger cars than in the morning. Differences in the number of remaining vehicles are too small to draw conclusions from them. Szewska, Karmelicka and Nawojki streets were selected for the analysis due to their location streets through which you can leave the city center. Szewska Street connects the Main Market Square and the 1st ring road, ul. Karmelicka connects the 1st and 2nd ring roads, and ul. Nawojki is an extension Czarnowiejska Street, with which they form a connection between the 2nd ring road and the planned one part of the 3rd ring road. Based on tab. 2, 4 and 8, the number of means of transport used was compared. The collected data indicate a different structure of means of transport in the studied street sections. The least variety of means of transport was observed on Szewska Street. Only pedestrians and cyclists constitute a noticeable group of people traveling. They constitute 87.5% and 11.6% of all, respectively means of transport. The largest group of funds is on Karmelicka Street transport are pedestrians (59.9%). Cars come in second place passenger cars (14.8%), and thirdly bicycles (11%). They came in fourth place taxis and cars used in the form of car-sharing (5.8%), and in fifth place are trams (4.1%). On Nawojki Street, the largest group are passenger cars (59.6%), and pedestrians second (18.5%). Delivery vehicles came in third place (8.9%), in fourth place are taxis and cars used for car sharing (4.1%), in fifth place are public transport buses (3.1%), and only in sixth place bikes (2.2%). It can be noticed that the farther from the Main Square, the number of pedestrians decreases. The difference between Szewska Street and Karmelicka Street is 464 people, but between Karmelicka Street and Nawojki Street it is 1,023 people. This means that for every 700 m further from the Market Square, the number of pedestrians decreases by approximately 500. On Szewska Street, a pedestrian passes on average every 3.5 seconds, on Karmelicka Street every 4.6 seconds, and on the street Nawojkas every 13.6 seconds. Pedestrian traffic is common within the 2nd ring road. A probable explanation for this phenomenon is the relatively short distances between destinations as well as restrictions on car traffic. By When planning traffic organization, it is worth paying attention to the fact that there

are pedestrians in two locations they accounted for over 50% of the traffic, and on Nawojki Street they account for almost 20% of the traffic. Kraków, as a city with a long tradition and historic buildings, was not adapted to heavy car traffic, especially closer to the center at the time of construction. There were no known cars in the buildings. This constitutes space limitations at transport infrastructure planning. Only 1 passenger car passed on Szewska Street for 2 hours, 383 on Karmelicka Street, and 1705 on Nawojki Street. 4.5 times more passenger cars passed on Nawojki Street than on Karmelicka Street. On Karmelicka Street a passenger car passes on average every 18.8 seconds, while on Nawojki Street every 4.2 seconds. Measurements from Szewska Street are statistically insignificant. The reason are traffic restrictions inside the 2nd ring road, which is often uneconomical in terms of time and it is financially difficult to drive through Karmelicka Street. There is Nawojki Street used by local traffic, as well as by people wishing to leave the city towards the north and west. The flow is hampered by traffic lights because it's right next to it there is a pedestrian crossing at the examined cross-section. However, none were observed formation of large road congestions. Based on the analysis, it can be concluded that that restrictions are introduced in the city center to limit traffic automotive, they work well. Car traffic on the street connecting the 2nd and 3rd ring roads is 4.5 times higher than on the street connecting the 1st and 2nd ring roads. 262 bicycles rode on Szewska Street for 2 hours, and on Karmelicka Street 284 bicycles, and 63 bicycles on Nawojki Street. Difference between bicycle traffic on Szewska and Karmelicka streets is not large, but compared to the street Karmelicka, bicycle traffic on Nawojki is 4.5 times smaller. This is due to the fact that on the section furthest from the Market Square more people travel by car or public transport. Moreover, probably on that outlet section passengers travel longer distances – which may be too much for some a long cycling route, e.g. from outside the city. In addition, cyclists quite often they avoid busy routes for the sake of their safety and driving comfort. It would be necessary therefore, conduct the study on streets and paths parallel to Nawojki Street. On Szewska Street, a bicycle passes every 27.5 seconds on average, and on Karmelicka Street every 25.4 seconds, and on Nawojki Street every 1 minute and 54 seconds. There are no trams, buses, minibuses or coaches on Szewska Street. Communication collective buses can run on the 1st ring road. Due to the short distances, access to it is relatively very good. The tests took 2 hours on Karmelicka Street 106 trams and 1 bus, while 89 KKM buses passed on Nawojki Street, 27 buses and 11 coaches. On Karmelicka Street the tram passes averagely every 53 seconds. One coach is statistically insignificant, but it is worth knowing that such vehicles are also able to drive on the street (the infrastructure is there prepared for it). A KKM bus passes by every 44 seconds on Nawojki Street, bus every 4.4 minutes and the coach every 10.9 minutes. Public transport both on the street Karmelicka and Nawojki Street are well developed and run frequently. There are no taxis on Szewska Street because traffic is not allowed there car. 150 taxis arrived on Karmelicka Street within 2 hours and cars used in car-sharing, and such vehicles at 116 Nawojki Street. Is that's 23% less. This is not a very big difference, but it may indicate that there is more people in more remote

places uses public transport from the Market Square and private cars. This may be due to the regular service on this route to and from work or university and covering longer distances. For long ones journeys, using taxis is not financially profitable. Moreover, on the street Karmelicka there are greater restrictions on vehicle traffic, some of which are taxis disabled. This makes them more attractive within the 2nd ring road. On the street A taxi or car-sharing vehicle passes Karmelicka every 48 seconds, and on Nawojki Street every 1 minute and 2 seconds. During the 2 hours of research, 1 car passed on Szewska Street delivery van, on Karmelicka Street 48 delivery vehicles, and on Nawojki Street 254 such vehicles. Szewska Street has restrictions on vehicle traffic, so the result is very small and statistically insignificant. Number of cars on Nawojki Street delivery vehicles was over 5 times larger than on Karmelicka Street. Under investigation it was observed that on More large trucks pass by on Nawojki Street and other large-sized ones. In the city center there are more narrow streets, where the vehicle is difficult to move. Additionally, traffic restrictions apply. Is very few large-format stores, which means delivery vehicles deliver goods in smaller quantities. Store warehouses are often located outside III bypass, so an entrance road towards the center is necessary to make multiple deliveries. A delivery truck passes on Karmelicka Street on average every 2.5 minutes, and on Nawojki Street every 47 seconds. It's worth realizing this traffic planning in the city that many people drive around the city to transport supplies for stores, renovation materials or letters. Such transport will be very difficult or even impossible to replace by public transport or transport bicycle. Based on the tests carried out, it was found that 1 car delivery van on Karmelicka Street is 8 cars passenger cars, and on the street Nawojki on average for 6.7 passenger cars.

Eighteen electric scooters passed on Szewska Street within 2 hours Karmelicka 22, and on Nawojki 9 street. Electric scooters are relatively new mode of transportation. Currently, most electric scooters are rented. Research has shown that for now it is a less popular means of transport than bicycles. On Szewska Street there are on average 14.6 bicycles per 1 electric scooter, on Karmelicka Street 12.9 bicycles, and 7 bicycles on Nawojki Street. An interesting observation is that the ratio scooters on Szewska and Karmelicka streets are similar to the ratio of bicycles on the above streets. The ratio of electric scooters on Nawojki Street to bicycles should be multiplied by 2 to obtain a similar result as on Szewska Street and Karmelicka. From this we can conclude that travelers have the same reasons they choose bicycles and electric scooters as means of transport. These are appropriate measures for people who do not have to transport large and heavy items and are not afraid wind and changing weather conditions, they travel on long routes appropriate for their condition/battery capacity and do not have balance problems. Riding an electric scooter requires less physical effort and is easier in transport and folding. An analysis was also made of passenger transport in terms of the structure of participation in the movement of people, divided into the mode of movement on Szewska, Karmelicka and Nawojki streets, taking into account the average transport in vehicles. In each of the three cases, the sum of pedestrians and those using public transport is greater

than 50%, and on Szewska and Karmelicka streets it constitutes over 80% of traffic participants. This proves that great attention should be paid when planning urban infrastructure and transport on pedestrian amenities, especially inside the 2nd ring road. From communication The collective road on Karmelicka Street is used by over 60% of people traveling through it examined cross-section. On Nawojki Street, due to the larger one percentage of people using it from cars, this percentage is 48%. It is therefore necessary to take care of yourself for the proper functioning of public transport. This is not just for the sake of it limiting the use of private cars, but above all improving comfort and quality of life in Krakow. The further from the center, the greater the importance passenger cars, and the importance of bicycles is decreasing. Because the street Nawojki is an exit street from the city, so the number of cars may be overestimated and lower number of bicycles compared to parallel streets.

## 5. Conclusions

The process of developing means of transport depends, among others, on: from transport policy city and residents' awareness of sustainable development. As can be seen in the example of a large metropolis such as Krakow, road traffic restrictions mean that relatively few people use passenger cars inside the 2nd ring road. On the examined streets there is the highest share of pedestrians inside the 2nd ring road and passenger cars on the 2nd ring road and further from the center. There is practically no public transport inside the 1st ring road. But The first ring road is in second place among the streets examined in terms of the number of KKM vehicles. Public transport other than public transport has a significant share on Aleje and Nawojki Street, i.e. on streets with significant passenger flows. Due to the limitations and large share of KKM in the city center, it is practically not profitable to introduce private transport or compete on routes located inside the 3rd ring road. The exception are streets constituting the exit route from cities. Each studied street has a means of transport that can be considered dominant on it: pedestrians or passenger cars. The smallest difference between the dominant and the second-best means was found on Rajska Street. Electric scooters constitute approximately 8.7% of bicycle traffic in Krakow. Devices personal transport was not observed in the study, but the share of devices supporting movement is marginal. In total, the largest number of passenger cars were recorded on all streets (8,763), of which 53% were on al. Mickiewicza. A total of 7,158 pedestrians were observed, 28% of them on Szewska Street. During the research, bicycles passed through, which constitutes 16% of passenger car traffic and 20% of pedestrian traffic. 28% of bicycle traffic takes place on Dunajewskiego Street. This means that the movement of individual means of transport in Krakow is not uniform. This especially applies to movement automotive. There are special communication routes running through the city way exploited by a given type of vehicles. This applies to both vehicles public transport

that runs only on designated routes, such as and vehicles of private persons. When planning the organization of transport in the city this should be taken into account. It is easier to properly plan optimal solutions in the case of several larger streets, e.g. by protecting against noise or ensuring quick passage, among others. thanks to Intelligent Transport Systems rather than trying to redirect traffic to many smaller streets. It also improves the quality of life of residents. Most people use public transport on the surveyed streets Passenger cars came in first place, while pedestrians came third. When designing changes to infrastructure, the expectations of groups using different means of transport should be taken into account. Every day, travelers make choices about which route to take or walk. Infrastructure may encourage or discourage them to do so, e.g. bicycle traffic on Nawojki Street is relatively low. probably due to heavy car traffic and lack of a dedicated bicycle lane. One possibility is to separate traffic, such as on Dunajewskiego Street (bicycle and pedestrian traffic largely takes place in Planty) or Aleje (where pedestrian and bicycle traffic takes place in Krakowski Park). The second is to separate parallel streets for specific means of transport. Drivers will be happy to choose their own route, where there are two lanes in each direction and few traffic lights. However, pedestrians most people prefer to walk along a quiet street, with green belts and no car traffic relatively small.

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## IMPACT OF WORKPLACE LIGHTING ON EMPLOYEE SAFETY

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**Purpose:** The aim of the topic is to present the breadth of the issue of lighting in the workplace. A topic often treated marginally by employers but having a positive and negative impact on the health and safety of employees.

**Design/methodology/approach:** The article is a review of the literature on the impact of lighting on the employee, applicable, basic legal requirements, and a review of selected available statistical data on night work and work in conditions of insufficient lighting.

**Findings:** During the preparation of the article, it was found that the impact of lighting on the employee and his safety depends largely on the employer, his knowledge and commitment. Legal regulations are not precise when it comes to ensuring proper lighting for employees. Most parameters related to lighting in the workplace can be adjusted, and thanks to this there is a chance for better comfort and safety at work.

**Originality/value:** The article is a kind of recommendation for the employer - it indicates the areas that should be paid attention to, e.g. take care of employees health.

**Keywords:** workplace lighting, ergonomics, safety, shift work.

**Category of the paper:** General review.

### 1. Introduction

The working environment, according to the definition, is the conditions of the material environment (determined by physical, chemical, and biological factors) in which the work process takes place (Rozporządzenie, 2023). One of the physical factors is lighting. For the employee to be able to perform his professional work safely, effectively, and ergonomically, the employer is obliged to provide proper lighting of the workplace, adapted to legal requirements, the needs of employees and new technologies.

The subject of lighting in the workplace, as indicated in the following article, is very broad. We can talk about the typical "artificial light", thanks to which it is possible to illuminate the workspace, i.e. local lighting, but also about the one that allows for night work, i.e. you are

an indispensable piece of equipment at the workplace. Shift work is associated with a temporary lack of access to daylight, natural, without which life is difficult. But properly selected lighting parameters can help in the work (Stefani, Cajochen, 2021). Lighting is also a matter of fire safety, i.e., emergency and evacuation lighting.

## **2. Basic legal requirements for workplace lighting**

The legislator in Poland imposes several obligations on employers related to ensuring safe, hygienic, and ergonomic working conditions. Some of them concern the lighting of workstations. The relevant regulations are in the Regulation on general health and safety regulations. The employer is primarily obliged to provide electric lighting at night or during the day when natural lighting is insufficient. Both types of lighting should be available in work rooms, and additionally employees should be protected against excessive sunlight. In further items, the legislator obliges to adapt daylighting to the type of work performed, in accordance with the requirements set out in Polish Standards. Also, the illuminance in the rooms should meet the following: the ratio of the average values of the illuminance in adjacent rooms, through which internal communication takes place, should not be greater than 5 to 1. When leaving the rooms where, for technological reasons, work is carried out in darkness (e.g. optical darkrooms), conditions should be provided to allow gradual adaptation of the eyesight (Rozporządzenie..., 2003).

The requirements for the illuminance value are contained in the lighting standard PN-EN 12464-1:2022-01 Light and lighting. Workplace lighting. Part 1: Indoor workplaces. The standard also describes guidelines for other basic lighting parameters: lighting uniformity, luminance distribution in the field of visual work, glare reduction, light colors as well as flickering and stroboscopic effect (PN-EN, 2022).

When talking about employee safety, emergency and evacuation lighting should be mentioned. The first mentioned type of lighting should be installed in rooms and workplaces where, in the event of a failure, health or life hazards may occur. The requirements are defined by the Polish Standard and other legal regulations. The employer must remember that the lighting installation installed in workplaces and corridors must not expose the employee to accidents and should not generate additional hazards (Rozporządzenie..., 2003). Emergency lighting is designed to safely complete the currently implemented work processes and safely leave one's workstation in the event of a sudden lack of basic lighting (Pawlak, 2017) e.g. during fire, evacuation. So, it is logical that emergency lighting must have its own power source. In addition, the discussed type of lighting is intended to illuminate the escape route, ensure easy location of fire equipment, or enable the operation of rescue services (PN-EN, 2005, 2013). According to the standard, evaluative lighting is one of the types of emergency lighting and is designed to illuminate escape routes and is used to illuminate evacuation signs (PN-EN, 2013).

### 3. Workplace lighting and its impact on the employee

Lighting, i.e. visible radiation, is one of the basic factors of the working environment. Inappropriate - with too little or, on the contrary, with too much intensity, it is often classified as a nuisance factor, i.e. causing, for example, employee discomfort, fatigue, irritability, or a general temporary deterioration of the psychophysical condition of a person (Králiková et al., 2021). You can observe a decrease in work efficiency, less diligence, a greater number of mistakes made by the employee, which in turn may lead to an accident at work. Over time, a factor that is burdensome for health and well-being can turn into a harmful factor, which, for example, will permanently worsen the condition of eyesight. At the same time, properly selected lighting can improve employee health (Cena et al., 2019) and increase work efficiency (Juslén, Tenner, 2005), which can also improve the level of security.

The task of the employer, in the first place, is to minimize the negative effects of lighting on the employee. The most important parameter that can be easily controlled is the intensity of light. It is defined as the areal density of the luminous flux falling on a given surface. Depending on the type of work performed, the employee should be adjusted to the appropriate level. The minimum illuminance in places where work is carried out must be at least 200 lux. The more difficult the work, requiring the ability to distinguish details, or the greater the comfort of work, the higher the intensity should be (PN-EN, 2022). Also, when employing older workers, over 40, remember about better lighting (Shi, Chen, 2023). Higher intensity of lighting affects better alertness and concentration of the employee (Smolders et al., 2021), and consequently improves safety. To assess the level of intensity of the parameter in question at workstations, it is necessary to measure the average intensity in the working area and the average illuminance in the field of the immediate surroundings. The obtained results are analyzed and compared with legal requirements.

To provide employees with conditions in which their visual acuity will be better and their visual function will increase, care should be taken to ensure that the luminance of the visual field is evenly distributed. The luminance distribution is determined by the values of the reflection coefficients of the surfaces in the room or at the workstation and compared with the ranges specified in the standard. When the distribution or range of luminance is inappropriate, the phenomenon of glare may occur, i.e. a state in which there is a limited ability to recognize and a feeling of discomfort (discomfort). Glare can also arise in the face of excessive contrasts (Sawicki, Wolska, 2018). Generally, it can be said that it is too much light reaching the organ of vision. Glare is divided into three types: direct, indirect and reflective, and they are distinguished depending on the direction of the luminosity (e.g. bright objects, light sources without luminaires), in comparison with the direction of observation conducted by the employee. The effects of the glare phenomenon include, above all, general fatigue, eye strain, stress, irritability, i.e. headache, and the like can lead to an accident at work. More specifically,

due to the effects, the phenomenon of glare is divided into: disturbing, unpleasant and blinding. Disturbing is characterized by a reduction in the ability to see, in a way that is noticeable to a human, but very brief - the worker sees haze for a moment. Discomfort glare is perceived as visual discomfort, negatively affecting the concentration of the employee - the biggest problem in the workplace. The last type, i.e. blinding glare, is characterized by complete haze and the inability to distinguish, for example, objects. (ciop.pl, 2023). This is a temporary phenomenon, but the employee may not notice the threat, and a fraction of a second will lead to an accident at work.

Another factor that the employer should pay special attention to is the color of the light, referred to as the color temperature. Light sources emit warm, neutral, and cool colors. The higher the illuminance, the higher the color temperature of the light source. The warm color optically enlarges the space and creates a more friendly atmosphere (Yun et al., 2021). The cold color, in turn, stimulates and promotes concentration (Jiayi et al., 2021). The color of the light should be selected to the work performed, the room - size, color of the walls, its equipment (e.g. furniture, worktops), purpose, and above all, the hazards present at the position.

Employees, in workplaces, are also exposed to an effect called flicker. It is described as a feeling of visual instability caused by a light stimulus (Mańkowska et al., 2022). The phenomenon can be observed, among others, when the light sources are damaged or there are voltage drops in the network. Today, not very often, flicker can be noticed when pulsating discharge sources equipped with a magnetic stabilizing and ignition system, e.g. when illuminating a room with fluorescent lamps or mercury lamps. Then the stroboscopic effect appears, i.e. a phenomenon in which the employee sees the immobility of elements, objects in motion. The phenomenon is extremely dangerous (Bullough et al., 2012), because it also occurs with machines with rotating parts.

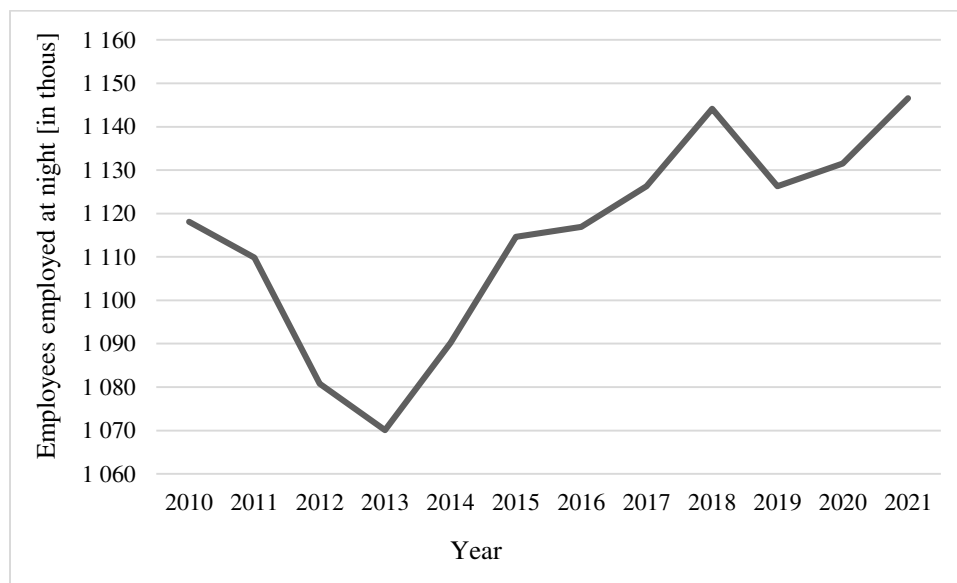
#### **4. Shift work - work at night**

Unfortunately, not all employees have the opportunity to work in conditions adapted to the biological conditions of humans. Often, due to the technological process, specificity of work or customer orders, work must be carried out at night, i.e. unnatural for humans, and this is associated with many negative health consequences (Cheng, Drake, 2019). Problems with the distribution of working time are related to the lack of daylight, forced circadian rhythm, lack of regular meals, stress, excessive mental burden, social pressure, etc. (Silva, Costa, 2023).

Shift work and night work is regulated by law. Requirements for employers have been collected in the Act - Labor Code. First of all, detailed rules regarding night work are defined by the entrepreneur in the work regulations - if the workplace is obliged to develop them and,

in the contract, concluded with the employee, or in an annex to the contract. The Act precisely defines nighttime as work covering 8 hours, between 21.00 and 7.00. In addition, if the employee's working time schedule includes at least 3 hours in each 24-hour period or at least  $\frac{1}{4}$  of the settlement period falls on nighttime, such work is considered as night work. In the case of work involving high physical or mental effort, and when the employee performs particularly dangerous work, the time of his/her work at night may not exceed 8 hours. A pregnant woman or a juvenile worker must not be employed at night (Ustawa..., 1974).

In Poland, night work, i.e. most often also shift work, is performed by over one million employees (GUS, 2022), as seen in Figure 1. Over the years 2010-2021, it seems that the number of employees working at night is increasing.



**Figure 1.** Number of employees employed in Poland at night, in 2010-2021.

Source: Own elaboration based on (GUS, 2022).

The harmfulness of night work is of great interest to scientists and is widely described in both domestic and foreign publications. It is described, among others, the impact of changing the circadian rhythm of employees (Bracci et al., 2019), the impact of the lack of natural lighting in combination with excessive artificial lighting, but also the possible positive impact of artificial light on productivity, cognitive functions of the employee (Dandan et al., 2021) and mental health (Mårtensson et al., 2015; Brown et al., 2020).

Lighting is important not only because of the vision process, but also regulates the secretion of hormones in humans, affects sleep (Bastos, Afonso, 2020) thermoregulation, level of alertness and eye-hand coordination (Żużlewicz, Wolska, 2014). Light, especially that with a high proportion, short wavelengths, in the blue spectral range, in the evening and during night work, inhibits the secretion of melatonin, which destabilizes the circadian rhythm of employees (Hebert et al., 2002; Gaggioni, et al., 2014), but properly selected can improve employee productivity (Viola et al., 2008).

## 5. Working conditions in Poland with particular emphasis on insufficient lighting of the workplace

In Poland, the working conditions, characterizing the places where work duties are performed and the risks to which employees are exposed, are assessed annually. Statistical data is collected and compiled by the Central Statistical Office (GUS). Some of the information comes from reports sent by large employers, and some is obtained directly. Surveys carried out by the Central Statistical Office are conducted using the representative method on a deliberately selected sample and cover entities employing 10 or more people. The results obtained from the sample are generalized to the general population of entities of the national economy (employing 10 people and more). Several million employees are subject to tests every year, in 2022 it was 6.8 million people. Among this number there were 443.3 thousand. employees employed in hazardous conditions – it constitutes 6.5% of employees (GUS, 2022).

In Polish statistics, workers employed in hazardous conditions are defined as persons who may be exposed to:

- factors harmful to health related to the working environment,
- nuisance factors,
- mechanical factors related to particularly dangerous machinery.

According to the data published by the Central Statistical Office, over 260,000 people were employed in hazardous conditions related to the working environment. employees. Nearly 100,000 people are in the group of employees at risk of arduous work. people. The least numerous groups were employees exposed to mechanical factors - over 81,000. Table 1 below shows the number of employees exposed to hazards per 1000 employees. The data refer to 2022 and show general values for all branches of the economy and industrial sectors as the one with the greatest number of threats (GUS, 2022).

**Table 1.**

*Employed in conditions of risk of harmful and dangerous factors as well as arduous for health in 2022*

Type of threats:		Per 1000 employees in units covered by the survey	Of which in industry per 1000 employees in units covered by the survey
<b>Work environment hazards</b>		<b>49.7</b>	<b>96.9</b>
Chemical substances		2.5	4.7
including:	carcinogenic	0.9	1.7
	mutagenic	0.2	0.1
Fibrosis dusts		3.4	7
Carcinogenic dusts		4.2	9.1
Other dusts		1.5	3
Noise		26.9	57
Vibration (mechanical vibration)		2	3.1
Hot microclimate		2.9	6.2
Cold microclimate		1.6	1.9

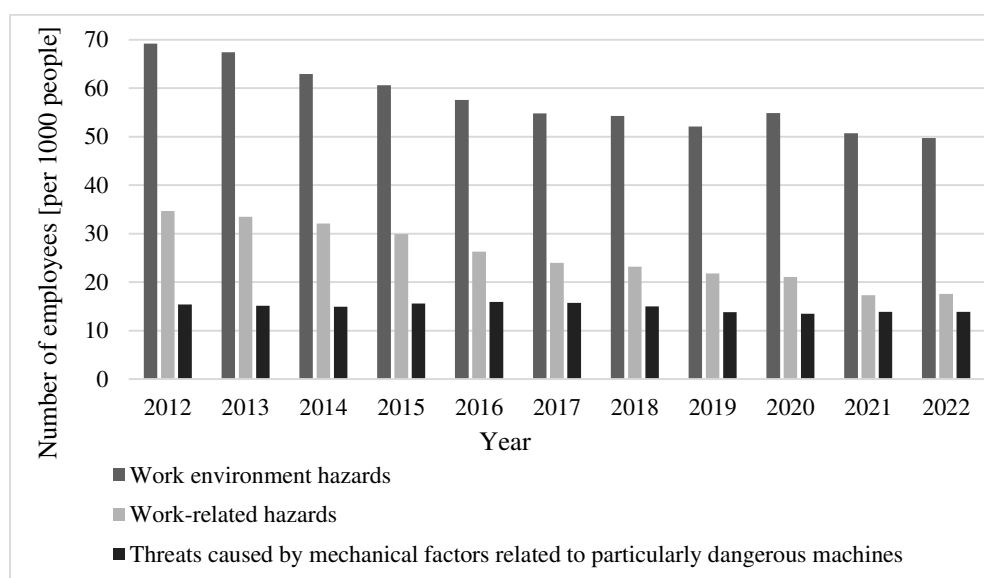


Cont. table 1.

Ionizing radiation	0.2	0.1
Laser radiation	0.1	0.1
Ultraviolet radiation	0.4	0.8
Infrared radiation	0.4	1
Visible radiation	0.1	0.2
Electromagnetic field	0.7	0.5
Biological factors	2.9	1.9
<b>Work-related hazards</b>	<b>17.6</b>	<b>29.2</b>
Excessive physical strain	10.6	17.5
Insufficient lighting of workstations	2.5	4.5
Other	4.5	7.2
<b>Threats caused by mechanical factors related to particularly dangerous machines</b>	<b>13.9</b>	<b>24.1</b>

Source: Own study based on (GUS, 2022).

The data presented in Table 1 shows that the greatest threat in Poland is noise, especially in industrial processing. Another factor that is widely present at workplaces is carcinogenic dust. From the group of onerous factors, excessive physical workload was mentioned above all. It is estimated that insufficient lighting of the workplace occurs in 2.5 people per 1000 employed in all surveyed workplaces, including 4.5 people per 1,000 in manufacturing. Insufficient lighting of the workplace is understood as failure to meet legal requirements (GUS, 2022).



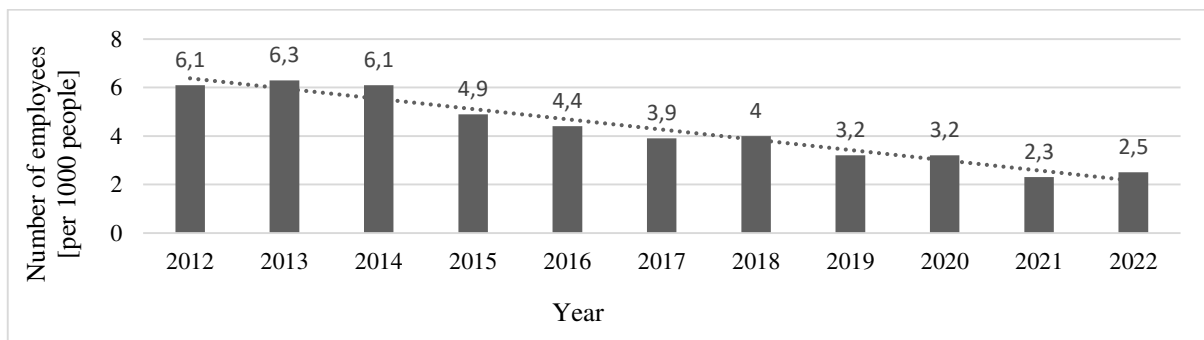
**Figure 2.** Number of employees working in hazardous conditions, in the years 2012-2022.

Source: Own elaboration based on (GUS, 2012, ..., 2022).

Working conditions in Poland are getting better and better, according to statistics. Figure 2 summarizes the number of employees exposed to hazards related to harmfulness of work, nuisance, and mechanical factors. The chart presents data for the years 2012-2022.

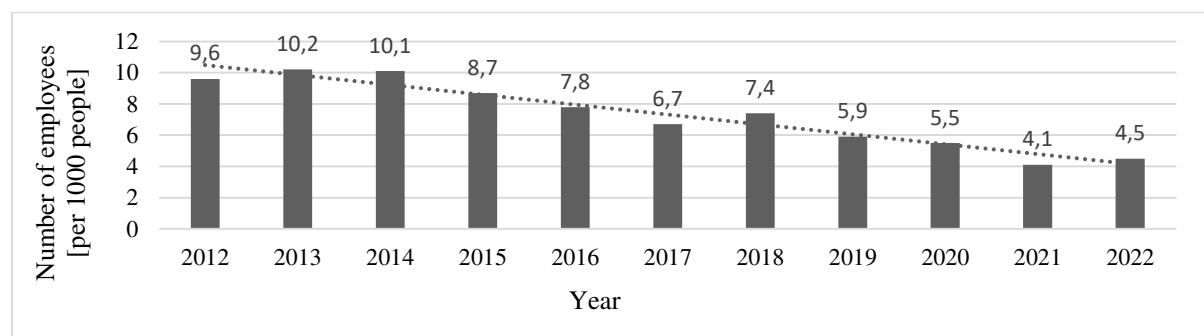
In the presented statement, these are not impressive numbers, but the very fact that the issue of lighting is monitored indicates the need to strive to improve working conditions in this area. In Poland, the relationship between improper or insufficient lighting and the causes of accidents at work is not monitored. Such a connection certainly exists.

The graph shows a clear downward trend in all three analyzed groups. The downward trend continues for employees exposed to harmful factors, such as noise, dust, microclimate, biological factors, vibrations and chemical factors. Over the last 10 years, the number of employees identified with burdensome factors at work, such as insufficient lighting at work stations, has decreased by almost 50%. Figure 3 shows the number of employees whose workplace lighting is incorrect, per 1,000 people employed in all industries in Poland, in the years 2012-2022. Figure 4 shows the number of employees at risk of improper lighting in the industrial sector, selected among all industries, also per 1,000 people employed only in industry, where working conditions are the most difficult.



**Figure 3.** Number of employees exposed to the risk of improper lighting of the workplace per 1000 employees, all industries, 2012-2022.

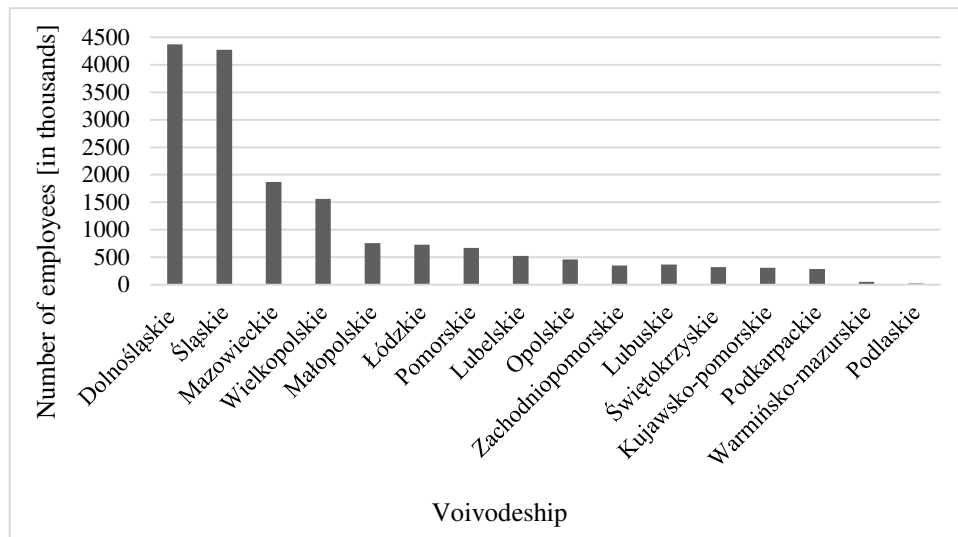
Source: Own study based on (GUS, 2012, ..., 2022).



**Figure 4.** Number of employees exposed to the risk of improper lighting of the workplace per 1000 total employees employed only in the selected industry - industrial sector, 2012-2022.

Source: Own study based on (GUS, 2012, ..., 2022).

Despite the obvious improvement of working conditions, the number of employees employed with lighting that does not meet the requirements is large. In 2022, it was almost 17,000. employees. It should be mentioned here again that only companies employing 10 or more people are subject to the statistics, so the picture of the data is incomplete. About 4.5 million microfilm workers were not considered. Nevertheless, a breakdown by voivodeships in Poland was prepared for the analyzed group (Fig. 5). The largest number of people employed in positions not adapted in terms of lighting work in the dolnośląskie and śląskie Voivodeships - 4373 and 4275 thousand respectively. employees. mazowieckie and wielkopolskie voivodeships were ranked next.



**Figure 5.** Employees in conditions of risk of insufficient lighting of workplaces by voivodeships in 2022.

Source: Own study based on (GUS, 2022).

As mentioned earlier, the greatest number of hazards are identified in industry, because most people working in hazardous conditions are employed there. Continuing the topic of insufficient lighting and people employed there, attention should be paid to industrial processing; mining and quarrying; generation and supply of electricity, gas, steam, and hot water; water supply; sewage and waste management; recultivation - in 2022, about 13,000 people worked there. It is followed by construction, health care and social assistance - about 1,000 employees each, whose workplace lighting is insufficient. Over 800 people employed in the industry: transport and storage, approx. 350 - trade; vehicle repair and about 250 employees - education (GUS, 2022). Other industries are omitted due to their insignificant share in the statistics.

## 6. Summary

Despite the many signaled areas of work in which the topic of lighting appears, there are still many unresolved issues. It is worth looking at the topic of working at a computer, types of lighting and lighting fixtures, or light pollution. The topic of lighting workplaces for the elderly or the visually impaired is extremely important and up to date. For employers, the topic of lighting is difficult, often overlooked and underestimated (Sawicki, Wolska, 2022). This may be because lighting, in principle, is not subject to, for example, work environment tests or employers have the appropriate knowledge. The data presented in the article, concerning employees employed at the risk of insufficient lighting of the workplace, shows that the problem exists. There is no information available on how this risk translates into the number of

accidents at work, but it is highly probable that there must be such a relationship. Incorrectly selected lighting intensity, wrong color, light effects, or night work can adversely affect the safety of employees. But the right light intensity or the right color can increase a person's alertness, perceptiveness, and concentration, and thus improve his safety.

## Acknowledgements

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## ENABLING DIGITAL TRANSFORMATION AND KNOWLEDGE MIGRATION: THE IMPACT OF NLP, AI, AND ML IN MOBILE APPLICATIONS

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**Purpose:** The study intends to draw attention to the limitations of human complex values, the absence of user-facing connectivity and interoperability among mobile apps, and how these factors have slowed down the pace of digital transformation.

**Design/methodology/approach:** Through Google Play Store download rates, the study tracked consumer interactions with digital transformation through mobile apps. Based on their categories, a total of seventy-eight (78) mobile apps were analyzed, contrasted, and assessed. Each download rate was interpreted as the user's acquisition of the integrated NLP, AI, and ML algorithms in mobile app system settings.

**Findings:** The findings demonstrated low user involvement in NLP, AI, and ML as tools of knowledge migration from mobile applications to digital transformation compared to the global population, and none of the 78 mobile apps have interconnection and interoperability with other apps.

**Research limitations/implications:** The study draw attention to the limitations of human complex values, the absence of (study) user-facing connectivity and interoperability among mobile apps, and how these factors have slowed down the pace of digital transformation. In order to advance the pace of digital transformation, there must be an active presence of non-user-facing connectivity and interoperability issues among mobile apps.

**Practical implications:** A wealth of research has shown that because people are complex, digital transformation has not succeeded and instead relies on human values and interactions. Furthermore, users' access and operational scope are restricted by the absence of connectivity and compatibility among mobile apps, resulting in an excessively dispersed distribution of knowledge and data.

**Social implications:** The ability to continuously drive improvements in the global economy from institutionalization to business and healthcare is made possible by contemporary instruments such as digital transformation and knowledge transfer. Emerging mobile applications that organize events, manage lectures, and transmit knowledge, human thoughts, and sentiments are the result of natural language processing, artificial intelligence, and machine learning. These technologies have revolutionized the traditional documentary into a digitalized system.

**Originality/value.** The study revealed that digital transformation has not achieved the anticipated transformation due to low user engagement and a lack of interconnectivity among mobile apps. As a result, knowledge migration has not been properly disseminated over the world.

**Keywords:** Natural language processing, artificial intelligence, Machine learning, Digital Transformation, Mobile Apps, Knowledge migration.

## 1. Introduction

One of the most technological driving forces behind global development, urbanization, and modern civilization has been the advent of mobile applications. Technology comes with changes to people's living styles which is a challenge to organizations to see into the challenges how they can accompany solution advances (Guarda et al., 2021). Mobile apps have a sophisticated way of collecting personal data, unique details, and in-depth knowledge from users and migrating to digital systems. The forces of demand and supply in mobile apps have an inelastic approach that takes users' data unaware. The algorithm embedded in the mobile app influences users' altitude, aptitude, approach to the environment, engagement with others and things around, and boosts users' confidence. The ability to reshape customer values to transform their operations using digital technologies to achieve a desirable interaction and collaboration using mobile apps can be seen as digital transformation. For instance, Facebook, Instagram, LinkedIn, Twitter, YouTube, WhatsApp, and many other mobile apps have tremendously changed users' attitude, aptitude, and confidence based on the amount of dataset collected from previous users. Institutions, businesses, organizations, and establishments wishing to generate brand customer value propositions to transform their models of operational needs, required new portfolios (Berman, 2012). For the past decades, a lot of transformations have taken place leading the world through a series of transformations known as digital transformation. In the wake of digital transformation, most institutions, businesses, religious establishments, and healthcare centers have launched mobile apps to interact with their users (Ho, Hsu, 2022). Mobile apps have become an important tool that allows business owners, educational providers, healthcare services, and Christians to have an encounter with God. Mobile apps are now a place for customers and retailers to engage in various ways and share data amongst themselves. Most businesses also obtain insight into what people think, believe, and feel about their products and services via mobile apps.



Many sectors that now host web pages today started with mobile apps. Although most institutions don't pay attention to the importance of mobile applications, it has been observed that they carry the details and information to wider areas. Mobile apps enable digital transformation to secure the most convenient multitasking abilities, applications, and system software for its users. The first mobile app used in the hotel was in 2009 (Bilgili, Koc, 2021). This application was known as RapidBook. Digital transformation is already swiping across all sectors like businesses and learning institutions through mobile apps and telemedicine are currently engaging as well (Wu et al., 2022). Since the outbreak of COVID-19, many institutions, businesses, and healthcare have increasingly engaged in mobile apps (Park et al., 2022; Banskota et al., 2020). Many institutions, businesses, religious establishments, and healthcare centers established good relationships with users during the pandemic. This process is still in divided tone as most systems are yet settled on their choice of the most preferred mode of functionality. Some institutions, businesses, and healthcare preferred continuous online via mobile apps while some prefer traditional classroom, shopping, and in-person services.

The study investigates Google Play Store download rates. During the findings, the study tracked consumer interactions with digital transformation through mobile apps, and their categories. A total of seventy-eight (78) mobile apps were analyzed, contrasted, and assessed. Each download rate was interpreted as the user's acquisition of the integrated NLP, AI, and ML algorithms in mobile app system settings.

Although a lot has been achieved with the development of mobile apps that has tremendously transformed many businesses, learning institutions, religious establishments, and healthcare centers, there is yet another big problem that is yet to be sorted out. The number one risk preventing the wider adoption of mobile apps into our day-day activities is the risk and security challenges associated with it. A survey was carried out (Schwertner, 2017), and their findings reveal that limited mobile app engagements in business are due to the risk associated with them. The lack of interoperability of mobile apps with other information communication technologies has limited the level of digital transformation. Until today, most mobile apps still operate independently without a possible system of a similar brand to interact with the same users. The lack of interconnectivity and interoperability amongst mobile apps has an adverse impact on the level of engagement from global use. There exists a limited control mechanism associated with mobile apps. Most owners independently managed these applications without a possible system that set standard regulatory compliance.

## **2. Literature Review**

Section is made up of Natural language processing toward Digital Transformation, Artificial Intelligence Towards Digital Transformation, Machine learning Towards Digital Transformation, Digital transformation overview Concept of Digital Transformation According to This Study Way Forward on Digital Transformation, and Way Forward Strategy on Digital Transformation.

### **2.1. Natural language processing toward Digital Transformation**

This section examined some literature reviews that highlight the importance of digital communication that is transforming our human communication from text, documentary, and mobile apps to a digital independent system. Amongst the complex and interdisciplinary context, computational tools based on linguistics, computer science, and artificial intelligence that can perform a feasible technique to support data analysis and discussion is no other system than natural language processing (Perazzoli et al., 2022). To (Locatelli et al., 2021) suggested building pairing Information Modeling according to EU aims to digitalize technologies to seize the full potential of the digital transition. The study analyzed 254 bibliographic records from Scopus Database analyzing the structure and dynamics. To (Kalyanathaya et al., 2019) examined the conversation systems with a focus on Language Processing, Machine Translation, and Deep learning. The combination of deep Learning techniques, and natural language processing is attracting a lot of applications in domains like healthcare, finance, manufacturing, education, retail, and customer service. Digital transformation is driven by a flood of software technologies (Ebert, Duarte, 2018). The study went ahead to list the software technologies which are sensor microdevices and actuators embedded with the internet of things, machine learning, artificial intelligence, and facilitating the convergence of IT like natural language processing. Following the precipitated change in the world observed during COVID-19, natural language processing has become an essential and focal point for most businesses. Many businesses driven by the power of artificial intelligence have resulted in the development of mobile apps that require sophisticated great details of customer insight. To (Di Giuda et al., 2020) investigated the state of art of textual translation theories, methods, and tools into formal and numerical requirements to support information modeling in the project management process. They revealed that natural language processing necessitated the application and success of information modeling that supports the management process for project management. To (Kasztelnik, Delanoy, 2020) suggests a novel technique for quantifying text from a questionnaire research instrument using the natural language algorithm for data insight business decisions. Their suggestions revealed that natural language algorithms and human domain knowledge can support a better understanding of essential business decisions. A natural language processing concept was suggested to handle digital shop floor management

in a manner that can further bring a higher value to the shop floor team and decision-makers (Müller et al., 2021). The study examined 2,735 entries for digital tickets for floor shop issues. The suggested technique was accurate, quick, and detailed. There is a rebirth in the field of natural language processing from the manual encoding of linguistic data into an automated corpus-based learning method (Brill, 1995). This transformation can only be observed as part of the digital transformation of computer linguistics challenging the traditional documentary.

## **2.2. Artificial Intelligence Towards Digital Transformation**

This section details techniques that transition our day-to-day activities from traditional documentary, analysis, solution-oriented, automated application and evaluation to a digital system with the help of artificial intelligence.

Artificial intelligence is a Technological advancement that is aimed at restructuring our lives, inspiring change, and ensuring a great future for the world at large (Sairete et al., 2021). Artificial intelligence is expected to grow up to 34% per year by 2030 in the United Arab Emirates. Healthcare, businesses, and retail are expected to greatly benefit from the profound development of artificial intelligence than other sectors of the economy. There is a change in the maritime and shipbuilding industry, and supply chain management due to the move toward digital ecosystems. This change has brought about increased operational complexity and requires a reliable communication and coordination system such as artificial intelligence (Diaz et al., 2023). There is an urgent need for artificial intelligence-based cybersecurity in the supply network that can predict and monitor shipbuilding supply networks and determine ripple effects from disruptions. Intelligent automation uses artificial intelligence to create smart processes that enable thinking systems, self-function, and self-adapt to their understanding to deliver automated services (Christou et al., 2023). This study examined intelligence autonomous systems that will transform into a digital transformation era. Artificial intelligence has been echoing in everyone's lips since the advent of ChatGPT (Holzinger et al., 2023). Open artificial intelligence has broken a record in the much-expected development in the field of artificial intelligence. The advances in artificial intelligence have resulted in a breakthrough in the following areas: Food Security, Health and Well-being, Clean Water, Clean Energy, Responsible Consumption and Production, Climate Action, and Life below Water. Digital transformation is a global transformation system that is capturing attention in every sector and encouraging major investment (Möller, 2023). Artificial intelligence stands as several emerging influencing transformation applications for industrial sectors. Digital transformation has one of the most important impacts on firm internationalization (Feliciano-Cestero et al., 2023). The study examined existing theories related to digital transformation and internationalization and their findings revealed that digital transformation impact firms both at individual, firm, and macro level.

### **2.3. Machine learning Towards Digital Transformation**

This section details techniques that transition our day-to-day activities from traditional documentary, analysis, solution-oriented, automated application and evaluation to a digital system.

A study to examine buyers' attitude on Facebook (Khoa et al., 2022) The study uses supervised learning of machine learning. The results revealed that informativeness, entertainment, interactivity, credibility, and personalization positively affected the buyer's attitude. Artificial intelligence is rebranding the way we live, learn, and work (Sarirete et al., 2021). The combination of the growing ICT-driven ability observed across our socio-economic political and cultural systems along with growing consumer expectations add value to whatever we are doing. The advances in technology, manufacturing, and engineering have made it easy for companies to produce high-quality products (Sahija, 2021). There is a need to establish more efficient processes to help companies grow and remain competitive. The study suggests the use of machine learning and augmented reality in optimizing basic discrete manufacturing processes such as improving plant Floor Operations, facilitating quality management processes, better prediction of failures, and facilitating inventory management. To (Malamousi et al., 2022) examined three objectives in the study. One of the interesting objectives of this study was the assessment of the performance of Machine Learning methods on the key enabling technology for thermal and cold spray. They examined surface engineering and discussed several adoption strategies. Digital transformation in the era of Industry 4.0 is manifesting through information techniques, computerized control, and communication networks (Çınar et al., 2020). The transformation of digital systems in Industry 4.0 can collect massive amounts of operational data and process it into pieces of equipment to harvest data for making automated fault detection and diagnosis. A study by (Aldhaheri et al., 2022, April) examined digital transformation using machine learning and the Quality of UAE Government Services and requirements. The study concluded that UAE institutions and bodies that seek to develop must invest in the creation of innovative services. The constant demands and increasing market competition are effectively exerting great pressure on the business to maintain its existence (Ramkumar et al., 2022, April). The development of digital technology that mostly depends on the platform uses advanced codes and machine learning algorithms.

### **2.4. Digital transformation overview**

A special issue examined digital transformation with the support of six in-depth contributions (Cho et al., 2021). The first contribution examined the impact of digitalization on profitability, the second contribution examined dissatisfied clients' repurchase behavior in online markets, the third contribution examined online intention to purchase, the fourth contribution examined the impact of customers' intention to continuously engaged online, the fifth contribution examined uncovered marketer-generated content relationship and the

sixth contribution review product evaluation and information perception. These sixth authors let us understand that there are great opportunities, business potential, and available ready users-owner insight when engaged digitally and there exist both human, capital and market development opportunities associated with digital transformation. To (Tabrizi et al., 2019) a survey of directors, CEOs, and senior executives argues that digital transformation is not about technology but about changing mindsets. Their study revealed that digital transformation (DT) risk was the number one concern in 2019. Out of the 70% of all DT engagements of about \$1.3 trillion spent on DT about \$900 billion went to waste. From the findings, only about 400 trillion succeeded. This study survey suggested five lesson steps to assist organizations to walk through digital transformation. A literature review and an online survey were launched to identify the importance of skills for an effective digital transformation (Sousa, Rocha, 2019). The findings revealed that mobile technology is important as more and more users engage in the use. The study suggests that most organizations should rethink their strategy regarding skills development to achieve a desirable result to the challenges of digital transformation. Digital transformation is a new competitive environment that is changing consumers' habits by pushing financial institutions to address their digitalization process as a matter of urgency (Cuesta et al., 2015). The study further explained that organizations required adjustments to secure a place in the digital systems to continue functioning. Enabling digital transformation (Gens, 2013), examined creatively leveraged technologies that transformed the relationship between businesses and customers. The creative leverage technologies are cloud, mobile, social, and Big Data. The study revealed that the changes are already taking place and will accelerate over the coming years. Indian digital transformation of library services was examined (Singh, 2018). Their survey consists of a 24/7-day evaluation. Their findings revealed that almost all academic libraries operate an e-resource. The digital transformation has revolutionized entire industries, but most organizations ignore or misapply the principles, ideas, and methods (Doukidis et al., 2020). A cross-sectional study examined and measured users' experience while using the Tawakkalna (AlGothami, Saeed, S2021). The study received 87 participants and among them, 75 participants had experience with mobile apps. The findings revealed that Tawakkalna is good with a score of  $1.51 > 0.8$ . The study recommended improvement to the app following feedback from the survey feedback. According to (Alekseevna et al., 2017) examine the stages of activity and society's digital transformation using a conceptual description. The study uses examples from media and retail to support their description. A low-code development platform for digital transformation was examined (Phalake, Joshi, 2021). They said new applications are not enough to face the rapid changes in the market but required methods that enable them to build their apps by configuring the functions instead of coding the software from scratch. According to (Schallmo et al., 2018) McKinsey defined digital as the creation of value, optimization of processes, and building foundational capabilities that support business initiatives. To (Nguyen Duc, Chirumamilla, 2019) study security risks associated with technologies from engineering management.

Their findings revealed that software security risks and future research work have implications for both practitioners and managers. A study investigates the transformation of ICT and its significance in business using the Apple pay system (Liébana-Cabanillas et al., 2020). Their study invited 539 users to respond to an online questionnaire, and an analysis of structural equations. Results revealed that imaginary benefit (perceived value) is the driving force (variable) that influences the desired (intention) to use. To (Zaharia, Pietreanu, 2018) outlines airport digitization trends, their structure, management, and means of implementation and identify the changes. The study revealed that Romanian airport challenges include appropriate IT infrastructure for future resource allocation. To (Heilig et al., 2017) studied digital transformation in the logistic system. The study identifies three stages of respective digital transformations using a well-known model from literature.

## **2.5. Digital Transformation concepts**

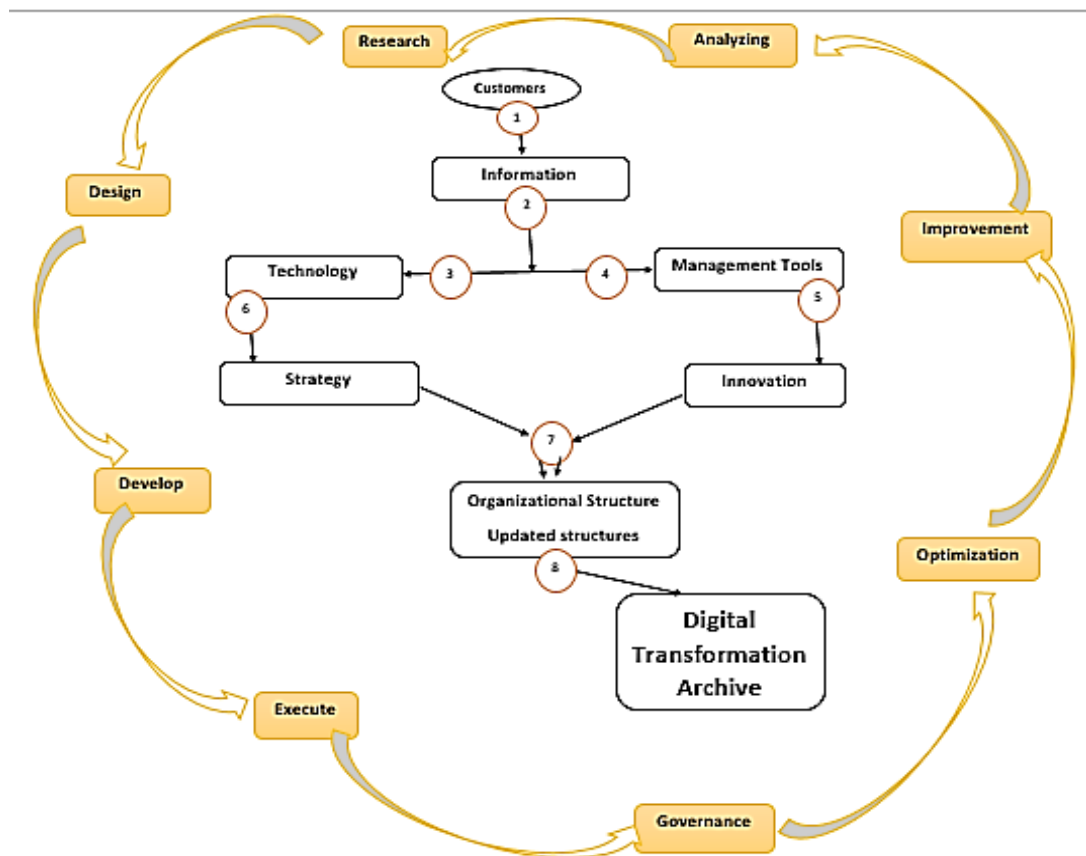
Digital transformation. A concept in business that is specifically focused on the human element, (Verina, Titko, 2019). According to (Morakanyane et al., 2017) said a lot has been said about DT both at the academic level and industrial levels but they still think there is a misunderstanding of the real concept of DT. They further said to fully understand digital transformation, there is a need to understand the concept with specifications based on terms of what it is, the characteristics, drivers, impacts, and transformed areas. To (Pihir et al., 2019) said digital transformation is a strategy focused on oriented and customer-centric changes to achieve and meet up with the innovative and emerging opportunities of information and communication technology.

According to (Gong, Ribiere, 2021) digital transformation is a very important change in technology for most organizations in our world of emergent and continuous changes in societies but the term DT has been so broadly used that it becomes very confusing. Since there is no concise approach to tackling DT, it has been used in many different approaches that are becoming more confusing to many businesses. Even though the changes are very fishable, many businesses still find it difficult to fulfill the requirements needed to run a successful business in tee a of DT.

### *2.5.1. Concept of Digital Transformation According to this Study*

According to von (Rosing, Etzel, 2020), the authors introduce a digital transformation circle that is made up of four stages Understand, Innovate, Transform, and Continuously Improve. This proposed circle is very useful, and this study finds it lacking some elements which would have made it more concise. The following format as per the figure below explains a wider concept that would better enhance digital transformation.





**Figure 1.** Digital transformation integrated circle.

Source: author's own copy.

Figure 1 above is a systematic integration of the circle of digital transformation according to (Rosing, Etzel, 2020). The finding of this piece of work that the author feels will put a much more concise approach to the concept of digital transformation. Many concepts have been put together by many researchers and industries to help businesses achieve a much better goal in the much-transformed society by technology. Many approaches conflict with others' opinions. This study keenly followed the concept put together by (Rosing, Etzel, 2020) to come up with the figure above. Figure 1 presents the concept of digital transformation in light of knowledge migration with the help of natural language processing, artificial intelligence, and machine learning as tools.

**Research (customers).** There is a need to research who the institution or organization or establishment or organizations focus is on. A thorough search should focus on the people in the market or target location both in the present and future. There should be a deep focus on natural language processing as it helps provide the approach to communicating with the target customers. Also, artificial intelligence should be the next technology to help institutions, businesses, establishments, and organizations predict the customer pattern of needs. Machine learning should be used to train the patterns of communication natural language processing provided for the research team to use and targeted the customers. Also, machine learning should be used to train the obtained data the artificial intelligence predicted about the customers.

**Analysis (information).** Natural language processing should be used to analyze language pattern designs and various languages associated with its target audience. Artificial intelligence should be used to predict design based on information captured by the customers. Machine learning algorithms should train patterns of the design required for technical development.

**Design (technology).** This section should focus on the technology required to fulfill the requirements needed in designing the products or services required based on the information gathered.

**Improvement (management tools).** Based on the prediction from the design section the type of management tools should be able to tell if there is need for a continuous improvement throughout the lifecycle or if used for a particular duration and dumped. With a focus on natural language processing, artificial intelligence, and machine learning, every system requires continuous improvement especially when it comes to human attributes. For instance, the language of a person required continuous improvement throughout the lifecycle and generations. Unlike systems incorporated to understand humans required continuous improvement.

**Optimization (innovation).** When products and services are not human-oriented, it is obvious that the system, application, and software don't require a deep focus on optimization but when they are human-oriented, there is a must to fulfill the need for constant optimization to meet up with human complex nature. The sixth stage (Development) (strategy). When a thin line is drawn between people oriented and non-oriented, a perfect strategy is reached for a better customer focus. Systems that decided to be product-oriented and serviced oriented don't require many optimizations in their development stage or throughout the process and Vis-versa.

**Execution (Organization structure).** When development focuses on people or customers the process is developed with a deal of optimization as a priority. When the execution stage was based on product-oriented and serviced oriented without customer focus, a deal should be reached with optimization as a non-essential requirement.

**Government (digital transformation archived).** It will be very easy to allow a business to continue on the eve of any technological advancement once it's able to fully fulfill the said stages above. Most institutions, business establishments, and organizations fail to achieve a digital transformation because of the choices they made during their development. Once a bad route is taken, it's often very difficult for a company to move forward. When a system doesn't give room for continuous optimization of its tools and employees, it is hard for such a company to succeed in the break of new technology. Once employees are unable to match with continuous optimization, it is very costly for a company to hire new employees to meet up with new technology. Also, when a company doesn't optimize its tools or types of equipment, it's very difficult to acquire new ones once in the break of a new technology. The choices a company made during its development stage have a big rule on its governance in the present and future.



### 2.5.2. *Way Forward on Digital Transformation*

Besides the many challenges associated with digital transformation, there are still ways companies, institutions, and organizations can survive these challenges.

1. There is a need for customer care with in-depth mobile applications.
2. There is a need for information awareness on the level of NLP, AI and ML integration.
3. There is a need for technological know-how-based user engagement with mobile apps.
4. There is a need for management tools for comprehension assessment of mobile technology.
5. There is a need for innovative openness between users and engineers.
6. There is a need for strategic openness at the level of NLP, AI and ML application in mobile apps.
7. There is a need for organizational structure flexibility to adapt to users' needs and wants.
8. There is a need for digital transformation awareness with effective application of mobile technology of NLP, AI and ML.

### 2.5.3. *Way Forward Strategy on Digital Transformation*

The figure represents a suggestion for future strategies for businesses based on different concepts introduced by the school of thought. The level at which technology is advancing is much faster than expected and there is a need for a standard approach to be followed by most businesses.

Digital transformation in the light of natural language processing, artificial intelligence, and machine learning through mobile apps as tools of knowledge migration to digital transformation should consider this approach.

Firstly, every business, institution, establishment, and organization should think about their customers (people, clients, and employees).

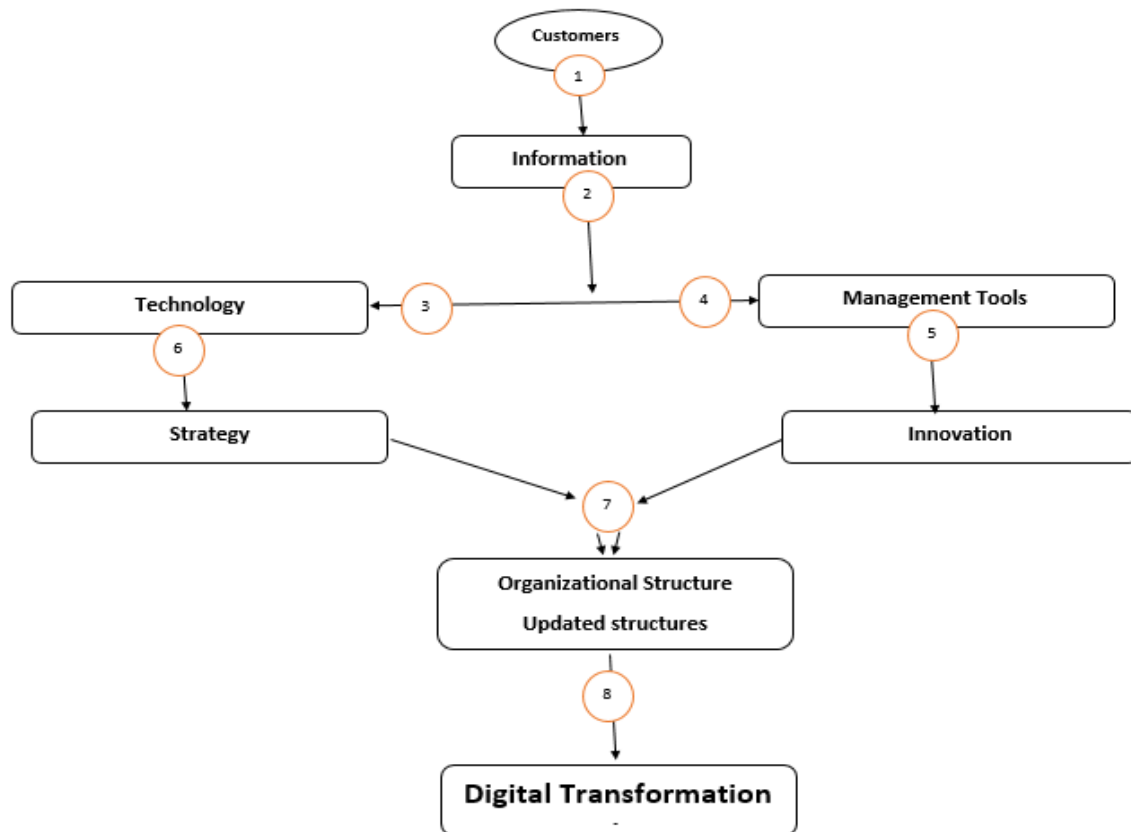
The second stage in the light of natural language processing, artificial intelligence, and machine learning as tools of knowledge migration to digital transformation should focus on information (data, and knowledge).

Thirdly, businesses, institutions, businesses. Establishments and organizations should think about technology (techniques of operations, implementation, and assessment).

Furthermore, the business, institution establishment, and organizations should think about management tools (Human resources, autonomous systems, or robot-assisted personnel)

The fifth level should be focused on innovation (optimization possibilities or rebranding or new developments).

The seventh level should be focused on the strategy (close encoded system or open system). Then the organizational structure (learning institutions, businesses, establishments or organizations).



**Figure 2.** future digital transformation strategy.

Source: author's own copy.

Figure 2 is all about the technological mobile journey to digital transformation. The first stage is customer focus, followed by information, technology, management tools, innovation, strategy, organizational structure, and digital transformation achieve. The reason for this proposed process is that customers are key to businesses' functions. Information nowadays is what makes up the technology that is driving the many changes in our societies. Most technologies are now business oriented, and they take into account management tools. For every business to succeed, it must focus on its innovative strategy. Innovation allows new ways to implement new technology. The strategy is required to meet up with technological advancements. Once a good open mindset is built within every company and its employees about the need for new ways of trying out functions. This is the best approach to maintain a constant strategy for meeting up with technological advancements. New stratifies and innovation allow the organizational structure to change without resistance from employers and stakeholders. Once innovation and strategies allow for change in organizational structures, there are high prospects for meeting digital transformation.

## **2.6. Other requirements for change**

- There is a need for onboarding, training, and support for the company's employees.
- There is a need to create change leadership teams There is a need for digital transformation consultants.
- There is a need to align digital transformation with the company's goals and strategies.
- There is a need for the company to be agile and flexible to meet new changes.
- There is a need for the company to strive to be up to date with digital transformation tools.

To summarize, one can say that digital transformation is a modern formal transformation in the 21st century that is aimed at allowing businesses to become more transparent, convenient, more open to the public, and more responsive to the immediate needs and wants of their employers and customers. The digital transformation has come with a set of rules and regulations called algorithms that if a business fails to rule along this transparent paradigm, it finds it very difficult to compete with others and eventually unable to fulfill its mission.

## **3. Applied Method**

This section examined some selection of mobile apps that are popularly used in educational institutions, business purposes, healthcare services, religiously oriented, and many others. The various mobile applications are examined as bridges of NLP, AI, and ML for knowledge migration to a digital transformation based on their various engagement. Each mobile app is evaluated in terms of user engagement based on the rate of downloads. Each application is examined in detail with regard to the total number of users in order to understand the level of transformation of natural language processing, artificial intelligence, and machine learning algorithms across the globe.

### **3.1. Mobile apps for educational-oriented services**

Students' perception of mobile technology adoption for library service apps was examined (Yip et al., 2021). The study revealed that mobile technologies in Hong Kong and most Asian countries have not been sufficiently studied.

**Table 1.**  
*Education Apps*

Mobile Apps	Web of Science	Mendeley	Wikipedia	Research Gate	Chat GPT	Academia. Edu	Google chrome	Mozilla Firefox	Yahoo	Microsoft office	Duolingo
Level Engage	50K+	50K+	50M+	100K+	5M+	1M+	10B+	100M+	100M+	500M+	100M+

Source: Own copy derived from play store.

### 3.2. Mobile apps for business-oriented services

A study was carried out to demonstrate how individual mobile users facilitate the using of mobile applications and their popularity of the mobile application (Islam et al., 2010).

**Table 2.**  
*Business Apps*

Mobile Apps	YouTube	Microsoft Teams	Zoom meeting	WebEx	Facebook	Twitter	Instagram	WhatsApp Business	Grammarly
Level Engage	10B+	100M+	1B+	100M+	5B+	1B+	1B+	500M+	10M+

Source: Own copy derived from play store.

### 3.3. Mobile apps for medical oriented services

A study examined Mobile apps for health-oriented services used in mobile devices by healthcare professionals that have transformed many aspects of clinical practice (Ventola, 2014).

**Table 3.**  
*Medical Apps*

Mobile Apps	MDCalc	MEDLINE	QxMD	Medscape	Micromedex	MediCode	UpToDate
Level Engage	1M+	1K+	100K+	5M+	100K+	500K+	1M+

Source: Own copy derived from play store.

**Table 4.**  
*Games*

Mobile Apps	Subway Surfers	Stumble Guys	Roblox	Candy Crush Saga	Race Master 3D	FIFA Mobile	Merge & Fight	Free Fire MAX	Bridge Race
Level Engage	1B+	100M+	500M+	1B+	100M+	100M+	5M+	100M+	100M+

Source: Own copy derived from play store.

**Table 5.**  
*Social Apps*

Mobile Apps	Instagram	Facebook	WhatsApp	Telegram	Messenger	Twitter	Discord	WeChat	Pinterest
Level Engage	1B+	5B+	5B+	1B+	5B+	1B+	100M+	100M+	500M+

Source: Own copy derived from play store.

**Table 6.**  
*Entertainment Apps*

Mobile Apps	Tik Tok	Netflix	YouTube	Amazon Prime Video	HBO Max	Rakuten TV
Level Engage	1B+	1B+	10B+	500M+	100M+	1M+

Source: Own copy derived from play store.

**Table 7.**  
*Shopping Apps*

Mobile Apps	eBay	Amazon	Walmart	OLX	Alibaba	Tiendamia
Level Engage	100M+	500M+	500M+	10M	100M+	1M+

Source: Own copy derived from play store.

**Table 8.**  
*Food & Drink Apps*

Mobile Apps	McDonalds	Uber Eats	Starbucks	Zomato	Foodpanda	Swiggy
Level Engage	100M+	100M+	100K+	100M+	100M+	100M+

Source: Own copy derived from play store.

**Table 9.**  
*Dating App*

Mobile Apps	Tinder	Bumble	Badoo	Tantan	Grindr	Snapchat	JAUMO
Level Engage	100M+	50M+	100M+	50M+	50M+	1B+	50M+

Source: Own copy derived from play store.

**Table 10.**  
*Money Transfer Apps*

Mobile Apps	PayPal	Google Pay	Cash App	Paytm	Alipay	NuBank
Level Engage	100M+	500M+	5M+	100M+	10M+	100M+

Source: Own copy derived from play store.

**Table 11.**  
*Fitness Apps*

Mobile Apps	Blood Pressure App Pro	Home Workout	Lucky Step	Da Fit	FitCoach	Zepp
Level Engage	10M+	100M+	10M+	10M+	10M+	10M+

Source: Own copy derived from play store.

**Table 12.**  
*Travel Apps*

Mobile Apps	Google Maps	Waze	Bolt	Uber	Booking.com	Flix Bus	Airbnb	FlightRadar24
Level Engage	10B+	100M+	50M+	500M+	500M+	10M+	100M+	50M+

Source: Own copy derived from play store.

**Table 13.**  
*Religious Apps*

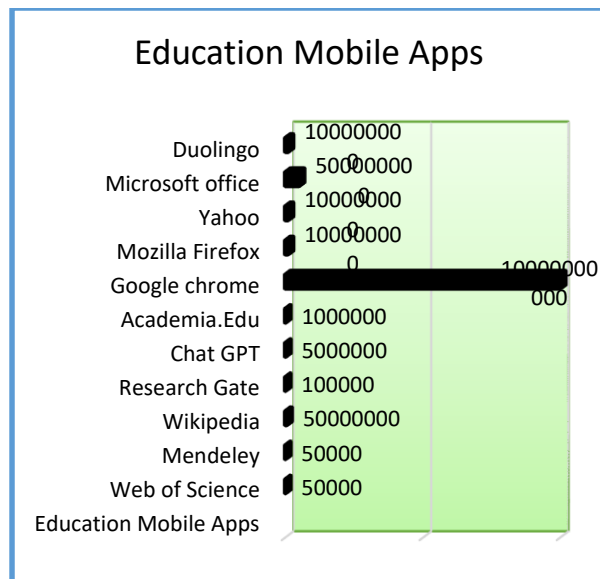
Mobile Apps	King James Bible	Good News Bible	Modern Worship	Watch and Pray	God is Good	Apostle Joshua Selman Sermons	Book of Enoch
Level Engage	5M+	1M+	10M+	100k+	100k+	10K+	100K+

Source: Own copy derived from play store.

Tables 1-12 represents the various selected mobile apps that this study examines in this paper. The methodology separated the mobile application into education, business, health, social, entertainment, social, dating, food & drinks, fitness, travel, religious, and shopping oriented. When the selection was done, the next step was to obtain data on each. The study uses the google play store to verify its mobile app download rate.

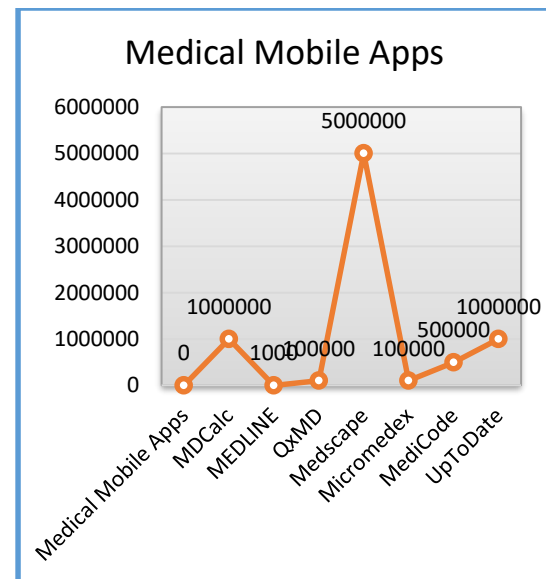
## 4. Results

This section provided an analysis of six mobile apps from Education, business, healthcare, social, entertainment, and religion. The selection is analysis to show the differences that exist and how users engage with mobile apps. The section show clearly which mobile apps are most relevant to the users based on their level of engagement.



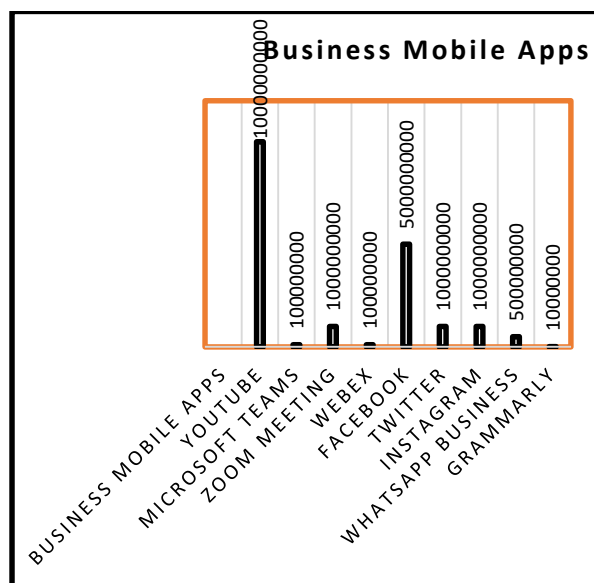
**Figure 3.** Education mobile apps.

Source: Author's own copy.



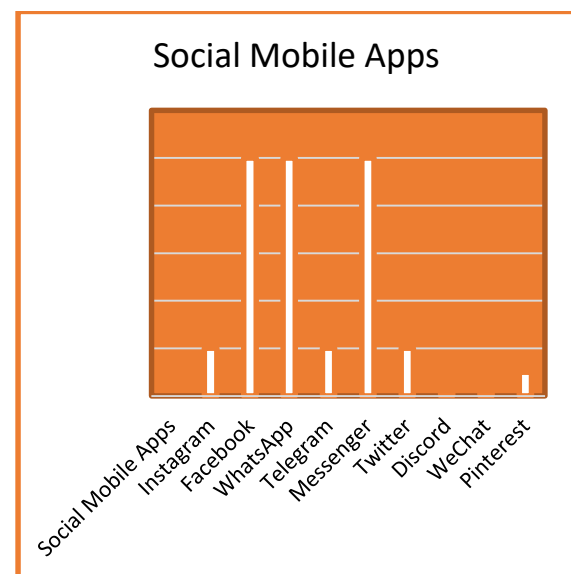
**Figure 5.** Medical mobile apps.

Source: Author's own copy.



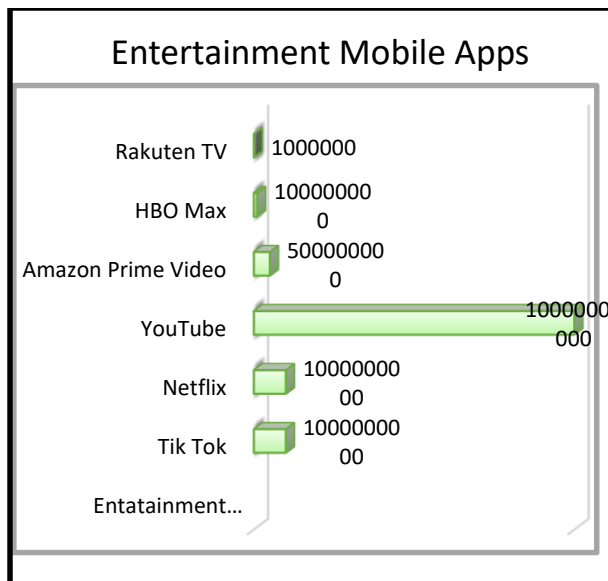
**Figure 4.** Business mobile apps.

Source: Author's own copy.



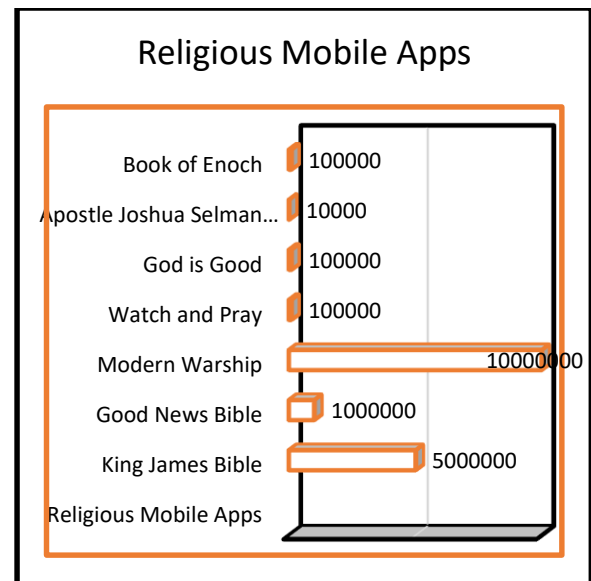
**Figure 6.** Social mobile apps.

Source: Author's own copy.



**Figure 7.** Entertainment mobile apps.

Source: Author's own copy.



**Figure 8.** Religious mobile apps.

Source: Author's own copy

Figures 3-8 represents the selected mobile apps in the following sectors of the economy (education, business, health, social, entertainment, and religious).

From the figures above, we can see that now exceeds a billion. When you compare with the world's population, we are able to independently agree that digital transformation is yet to achieve its desired success rate based on human laxity in engaging and interacting with technological advance applications. The advent of mobile applications has a way and technique of integrating the world into a single central system that closes the gap between industry, education, business, healthcare entertainment, social, religious, and political sectors, policymakers, and practitioners. Figures 3-8 and Table 1-12 show that none of the mobile apps according to the examination have not exceeded 1 billion. The world's population is about 8 billion and if we take off 25% for pupils under 18 years, the world's population will be 6 billion that can effectively engage with mobile apps.

## 5. Challenges/Limitations of Digital Transformation

**Security.** The transformation of organizations, institutions, establishments, and companies from traditional systems of management to the digital space has come with high-level security challenges. Companies battle with a lack of digitally skilled employees and the same time with the search for specialized to manage cyberspace against malicious agents.

**Competencies.** One of the challenging factors in digital transformation is competency. Matching client awareness with employee services, the company's products, and goals is quite challenging based on the level of know-how from the client's side due to the rapid digitalization of the information system.



**Organizational structures.** Coming to light of the advent of digitalization has put industrial performance to the big test. Companies, organizations, institutions, and establishments are now required to restructure and transform to something much more flexible to meet global changes.

**Support.** The new management approach and data available for employees is too huge which is posing a big management warfare for most employers. Companies nowadays pay very little attention to employees' demands due to the vast data available. Employees are now required to develop both technological and analytical skills to meet up with technological pressure, but face set back because of limited support.

**Complex software.** The constant changes in technology are giving companies, organizations, and institutions a very hard time in their day-day business approach. Most organizations are forced to search for new skills, tools, applications, and techniques to meet up with technological upgrades. Every day new technological tools emerge, and companies are required to acquire these tools. The cost of this equipment is sometimes very expensive.

**Cultural mindset.** The world is constantly evolving. As the world shifts from being a local village to a global village, there have been a lot of changes concerning cultural norms. Digital transformation is pushing into the world a similar culture based on technological programs. The way most young people and some elderly is very different from the way they used to in the past. The pressure becomes too advanced which is posing a huge challenge for companies in understanding their customers.

## 6. Conclusion

Natural language processing, artificial intelligence, and machine learning have a great algorithm that runs across borders, triumphs over language barriers, and fulfilled almost all the modern-day needs and wants that are stocked in our modern-day preferential world's advanced opportunities. Digital transformation is globally understood as a complex problem where management, Institutions, organizations, establishments, and businesses need to balance between achieving organizational agility, vision, goals, and objectives. The study concluded that a reshaping of user's value, and influencing their operations and interaction with interoperability and interconnectivity mobile apps would do a much better for digital transformation. There is a need to put users' knowledge into a central location that can be easy to study by most sectors of the world to produce better-tailed products and services. It is very difficult to resist the modern changes put at our disposal by digital transformation. The benefits of students relying on the tools put together thanks to digital transformation are more economically significant to the growth of institutions, businesses, healthcare, and most

importantly a country. Any resistance to adapting to the desires, needs, and wishes of students faces a very adverse impact on the students, institutions, businesses, and healthcare.

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## FACTORS INFLUENCING THE ENVIRONMENTAL EFFECTIVENESS OF THE DAIRY INDUSTRY IN POLAND

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**Purpose:** This study aims to identify the environmental impact of dairy plants in Poland, considering their social, economic, legal and managerial aspects.

**Design/methodology/approach:** The data was collected using CAWI and IDI.

**Findings:** Factors influencing the studied organisations' environmental performance were defined.

**Research limitations/implications:** It can be extended to the food industry or manufacturing companies.

**Practical implications:** As a result of the research, the article contains recommendations for further actions to improve the EPE of organizations, not only in the dairy industry.

**Social implications:** Research results and recommendations may impact CSR because the information in the article can be used to improve activities in the field of the organization's environmental impact.

**Originality/value:** The article contains original research results, their interpretation and recommendations for enterprises.

**Keywords:** environmental effectiveness, dairy industry, environmental factors, environmental impact, environmental management.

**Category of the paper:** Research paper.

### 1. Introduction

The dairy industry in Poland has experienced significant growth since joining the EU, with dairy exports growing by 400% (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2021). The dairy sector is a vital component of the country's agricultural economy, with a significant economic impact and a competitive presence in the global market, particularly

in cheese production. The industrialization of milk and the production of its derivatives, at a global level, contributes to social and economic benefits for society and generates significant environmental impacts (Üçtuğ, 2019). The industries of the dairy sector, considering these environmental impacts, must be concerned and contribute sustainably and efficiently to the industrialization of products (milk and its derivatives) in a sustainable, nutritious, and safe way (Augustin et al., 2013).

The EU Green Deal and the "Farm to Fork" Strategy have set demanding environmental objectives and ambitions, posing new challenges for European dairy producers and farmers (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2021). Considering this context, to be sustainable, the dairy industry must also present an efficient environmental performance and generate economic and social benefits (Feil et al., 2023).

There is apprehension that introducing more stringent environmental standards could lead to a reduction in milk production. However, despite these concerns, there exists an opportunity for enhanced sustainability within the dairy sector (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2022). A study on Norwegian dairy farms that incorporated an environmental output measure and drew on 30 years of panel data from 692 specialists (1991-2020) found that dairy farms are inefficient but have room for improvement in the dairy production system and the environment (Alem, 2023). This potential can be driven by policymakers encouraging the best-performing dairy farms to share information on increasing productivity while considering environmental concerns (Alem, 2023). Nevertheless, it is expected to observe that organizations, including those within the dairy sector, often neglect the importance of regularly updating and preserving sustainability performance (Li, Mathiyazhagan, 2018). Production and management processes typically fall short of meeting sustainability standards (Blok et al., 2015), and in fact, many industries are reluctant to integrate sustainable practices into business operations (Luthra et al., 2017; Feil et al., 2023), finding it challenging to balance productivity and environmental efficiency. Research findings also suggest a weak correlation between establishing environmental objectives by organizations and changes in their environmental performance indicators (Matuszak-Flejszman et al., 2019).

Environmental effectiveness can be achieved more with less - more agricultural outputs in quantity and quality for less input of land, water, nutrients, energy, labour, or capital (Keating et al., 2010; Czyżewski et al., 2021). This encompasses maximizing agricultural production or minimizing input usage while minimizing negative environmental impacts (Alem, 2023). Environmental effectiveness is an antecedent of environmental performance and a mediator of the relationship between organizational factors and environmental performance (Tung et al., 2014). Managers must focus on organisational factors to enhance environmental management's effectiveness: employee participation, teamwork, top management support, and training (Tung et al., 2014). Evidence suggests that employees' environmental awareness and management commitment are essential factors affecting environmental effectiveness (Matuszak-Flejszman, Paliwoda, 2022) and also impact the environmental awareness of subcontractors and suppliers.



## **2. Characterization of the dairy industry in Poland and its impact on the environment**

The characterization of the dairy industry in Poland aims to demonstrate and strengthen its importance to humanity and, in addition, its positive and negative social, economic and environmental impacts.

On the world market in 2022, despite the reduction in production in many regions, the upward trend in milk production continued. In the November 2022 forecast, FAO of the United Nations predicts that 2022 global milk production will reach 930 million tons, 0.6% higher than in 2021. This means that the international market for dairy products will be one of the most dynamically developing food markets (OECD/FAO, 2022).

European Union countries are significant producers of milk and milk products. The leading EU milk producers in 2022 are five countries (Germany, France, Poland, the Netherlands, Italy and Ireland) responsible for approximately 70% of EU production (European Commission, 2022). Despite the EU's measures to reduce the concentration of dairy herds, which were aimed at reducing the impact of milk production on the environment (Bienkowski et al., 2021), at the end of 2020, there was a substantial increase in their productivity (by 6% than 12 years earlier; the average milk yield of 1 cow increased by 21%), which consequently allowed for positive dynamics in the production of raw material for processing (Eurostat, 2020).

According to the European Commission's forecast for 2023, with a further reduction in the number of kept animals and a relatively small increase in milk productivity, EU milk production will amount to 152.6 million tonnes, i.e. 0.2% less than in 2022. Market analysts also predict production declines in the longer term. The EU's climate policy will mainly influence it. In the European Union (EU) alone, the increase in milk production is expected to slow down to almost 0.5% per year, and by 2031 it will reach 162 million tonnes. Furthermore, organic milk production in the EU is expected to grow (earning 8% in 2031), leading to economic benefits, environmental benefits and overall animal welfare (The EU Agricultural..., 2021).

Poland is currently a significant EU and world milk producer. Among EU countries in terms of the amount of milk produced, it ranks third, while on a global scale, it ranks 12th (Europa Commision, 2023). According to data from the Ministry of Finance, in 2022, the export value of Polish dairy products amounted to a record EUR 3.6 billion and increased by as much as 37% compared to 2021. Therefore, it is considered an essential segment of the food products market with high development potential and participation in creating Polish GDP from agriculture. The largest share in processing is the production of whey, skimmed milk powder and butter. In 2022, raw cow milk production was higher (approximately 2.2% than in 2021) than the internal demand, which created the possibility of exporting the surplus to foreign markets - about 70% were EU-27 countries (KOWR, 2023).

Moreover, the Polish dairy sector is among the few in the domestic food industry where most market leaders are Polish entities. Farmers who are co-owners, together with the processing plant itself, create highly vertically integrated enterprises that, in principle, operate stably in this volatile market. It should be emphasized that the Polish dairy market is currently ruled by the following companies: Mlekovita, Mlekpól and Polmlek (Portal Spożywczy, 2023).

As a result of the consolidation of smaller companies, they are becoming more vital and valued brands in the domestic and foreign markets. The observed structural changes in the Polish dairy industry result, to a large extent, from the processes of adapting companies to uniform EU market conditions. The thorough modernization of milk production and processing technology has enabled producers to significantly improve the quality of dairy products, which, in addition to the cost and price advantage of Polish milk producers, significantly affects competitiveness in the EU market. This, in turn, increases the negative impact on the environment resulting from the activities of enterprises in this industry. The food industry in Poland consumed approximately 793 hm<sup>3</sup> of water annually in 2014, with dairy accounting for as much as 35% of this consumption (Boguniewicz-Zabłocka et al., 2019). The negative impact of dairy farming on the environment is also reflected in the generation of large amounts of sewage. It is estimated that processing one liter of milk produces 0.2-10 liters of wastewater (Gramegna et al., 2020). Dairy sewage, compared to municipal or domestic sewage, is characterized by a higher content of organic substances, mainly nitrogen and phosphorus compounds, which - if discharged into the environment without appropriate treatment - increases the risk of eutrophication of reservoirs and watercourses (Kolev Slavov, 2017). Disposing dairy wastewater without or partial treatment remains problematic and requires a cost-effective and straightforward solution (Kasmi, 2018). The dairy industry also generates vast amounts of production and packaging waste. Kasmi (2018) points out that the wide variety of dairy products produced by the dairy industry generates a variety of wastes in terms of quality and quantity that can cause serious contamination problems. Diversification and quantification of waste from dairy organizations can be generated regardless of the industry's size and the industrial plant's size.

Company coal-fired boiler rooms cause air pollution (emissions of SO<sub>2</sub>, NO<sub>2</sub>, CO, CO<sub>2</sub>, soot and ash). Dust from the spray drying process of milk or whey and freons and ammonia compounds escaping from refrigeration installations are also a significant problem (Kasztelan, 2012).

Legal regulations related to the sustainable development of the food industry - the "Green Deal", the "farm to fork" strategy and the "circular economy" - the so-called zero waste, are a challenge for food producers and processors (European Commission, 2020). The tool for implementing these activities is the development by dairy industry organizations of an environmental policy allowing for a structured approach to environmental protection, which will be consistent with the assumptions and goals of the ecological policy of the state and the EU (EEA, 2019).

As part of pro-environmental activities, the dairy industry uses various solutions to reduce the negative impact on the environment. These activities are mainly aimed at reducing the amount of waste and reusing it. The literature indicates numerous ways of using dairy waste and sewage sludge to produce value-added products. If no other way of management is possible, waste and sludge may be subjected to energy recovery processes, both thermal and electrical. It is expected to modernize installations and implement water and heat recovery systems, which reduce the amount of raw materials used. Optimizing energy consumption in enterprises using renewable energy sources, in turn, allows for reducing emissions of harmful substances and enables effective energy management (Gralak et al., 2022). In addition, innovative and eco-friendly product packaging is used.

However, the transformation of the Green Deal in the Polish dairy industry requires enormous effort in the: 1. Transport; 2. Fuels and energy sources used; 3. Monitoring greenhouse gas emissions and water pollution (ensuring a decrease in emissions by approximately 1% per year); 4. Reducing greenhouse gas emissions (about 30%, by 2030-2035); 5. Phasing out or significantly reducing the use of hard coal (by 2050); 6. Waste reduction and reuse; 7. Use of advanced techniques/technologies supporting the circular economy; 8. Production of products with a low carbon footprint and 9. Systemic solutions in managing work organization in the company. The consequence of these requirements for the sustainable development of enterprises was the increase in capital expenditures in the investment structure observed in 2019 - most often the purchase of machines and equipment. Buildings and structures also had a large share. Significant investments (development of the technical, technological and product base) included mainly storage and logistics bases and energy, water and sewage management installations (EDA, 2019; European Commission, 2020).

Polish companies managed to achieve improvement in the context of the impact of dairy organizations on the natural environment in the following areas (Parashar et al., 2016; Boguniewicz-Zablocka et al., 2019; Bataille, 2020; Fiore et al., 2020; Muradin et al., 2023; Szymańska, Mroczek, 2023):

- emission standards (carbon footprint of the product/organization, low-emission fuels, monitoring the amount of substances emitted into the air);
- energy efficiency (production of energy from renewable sources, limiting the share of hard coal, heat and energy recovery system - cogeneration system, application of BAT, reducing the energy consumption of processes, reducing the emission of gas fuels, modernization of installations);
- waste management (use of the electronic Waste Database, waste recycling, innovative packaging and eco-labelling, ecological education);
- water and sewage management (subjecting waste and sludge to energy recovery processes - thermal and electrical, reduction of pollutants in water and its recovery, monitoring and control of consumption rates, use of dairy waste - e.g. whey and sewage sludge to produce various types of added-value products.

In addition to implementing activities under the sustainable development strategy (environmental and financial aspects), the organization's management is obliged to conduct constant information activities, consisting of communicating to consumers, stakeholders or state organizations (Hadryjańska, 2015) about the credibility of its "green" projects (Pink et al., 2022). The tools used for this purpose are voluntary environmental management systems (eco-labelling and reporting in ISO 14001, EMAS, CSR, ESG), characterized by clear rules for informing interested parties and used only where feasible and appropriate.

### 3. Environmental impact of the dairy industry

The dairy industry has a significant impact on the environment. Data focus mainly on greenhouse gas emissions, water pollution, habitat losses, air pollution and animal suffering. The dairy sector produces greenhouse gas emissions, including methane, nitrous oxide, and carbon dioxide, contributing to climate change (WWF, 2023; 2019). According to the average eco-efficiency score, conventional dairy farms could cut input use and CH<sub>4</sub> emissions by 5% while maintaining output (Alem, 2023). Also, dairy production significantly affects water quality through eutrophication, acidification, and biological and chemical pollution (Pope et al., 2021) due to the high concentrations of harmful contaminants in dairy wastewater (Al-Tayawi et al., 2023). Dairy operations can consume large volumes of water to grow feed, water cows, manage manure, and process products.

Additionally, manure and fertilizer runoff from dairy farms can pollute water resources, contributing to the growth of algae, which reduces oxygen for aquatic plant and animal life. Unsustainable dairy farming and feed production can lead to the loss of ecologically important areas, such as prairies, wetlands, and forests (WWF, 2023). Airborne ammonia emissions can damage downstream habitats, resulting in the loss of species diversity. The particulate matter and odour output from on-farm activities can negatively impact air quality (Hussain, 2022). Regarding the manufacturing of dairy products, the primary environmental impacts are (Szymańska, Mroczek, 2023; Antonopoulos et al., 2018; Rad, Lewis, 2014; Place, Mitloehner, 2010):

- by-product generation (resulting from processes such as coagulation, curd treatment, drainage, and pressing);
- wastewater generation (producing whey from coagulation, curd treatment, drainage, and pressing) and creating brine during the salting stage. Additionally, it plays a significant role in cleaning and disinfection operations);
- energy consumption (including thermal energy usage, such as for pasteurization, cleaning, and disinfection operations, as well as electricity consumption, particularly for refrigeration);
- water consumption (primarily in cleaning and disinfection operations).

However, the industry can significantly reduce environmental impacts through better management practices and technologies. The Sectoral Reference Documents (SRDs) on Best Environmental Management Practices (BEMPs) prepared by the European Commission provide guidance and inspiration to organizations in specific sectors to further improve environmental performance. Research findings indicate that the requirements related to the application of BEMPs contained in the SRDs may significantly contribute to an increase in effectiveness (Matuszak-Flejszman, Paliwoda, 2022). The Food and Beverage Manufacturing industry guide encompasses a series of practices to reduce its adverse environmental footprint. These practices include conducting environmental sustainability assessments for both products and operations, implementing sustainable supply chain management, enhancing or choosing packaging with minimal environmental impact, adopting eco-friendly cleaning procedures, refining transportation and distribution methods, optimizing freezing and refrigeration processes, implementing energy management and enhancing energy efficiency across all operations, and incorporating renewable energy sources into the manufacturing process. Furthermore, it promotes the prevention of food wastage within manufacturing operations (Antonopoulos et al., 2018).

#### **4. Research Methodology**

The empirical research was conducted in 2023 among dairy industry enterprises. The geographical scope of this study was Poland, which is located in the middle of Europe. The primary methods used in this study were Computer Assisted Web Interviews (CAWI) and Individual In-depth Interviews (IDI). These research tools were strategically selected to ensure a holistic understanding of the subject matter and provide a good perspective on the issues under investigation. CAWI served as one of the principal data collection techniques in the research. It involved administering structured questionnaires through an online platform called Webankieta. Respondents from various dairy industry enterprises in Poland were invited to participate in this survey via the internet. The use of CAWI offered several advantages, such as the ability to reach a large and diverse sample of participants efficiently. It allowed for standardized data collection, reducing the risk of interviewer bias and ensuring consistency in the responses. The online format also enabled real-time data entry and management, facilitating data analysis. In addition to CAWI, the research included IDIs to go deeper into the subject matter. IDIs are a qualitative research method that involves in-depth discussions with selected participants. These interviews were conducted with key stakeholders and experts. The purpose of IDIs was to gather detailed insights. This approach allowed the research team to capture qualitative data that complemented the quantitative data obtained through CAWI.

In the first stage, 22 properly completed surveys were collected, representing 32.5% of dairy industry enterprises operating in the Polish market. Among the surveyed entities, medium-sized companies dominated (63.6%). Large enterprises accounted for 27.3%, while small ones constituted 9.1%. Small and medium enterprises (SMEs) are essential for global green growth and eco-innovation. The study's second phase comprised Individual In-depth Interviews (IDI) with organizational representatives. These IDIs were carried out via online platforms, offering convenience and flexibility to the participants. The IDI questionnaire was standardized and segmented into sections, facilitating a comprehensive exploration of the organizational viewpoint. The data collected through IDIs was qualitative. The information presented in the results and discussion in this paper is based on research derived from the CAWI survey conducted in the first stage. The data collected in this study is non-sensitive and does not encompass health, genetic information, intimate details, political views, ethnicity, beliefs, or religious convictions. The study did not involve continuous tracking or observation of the participants. Participants were engaged in completing survey questionnaires, and their responses were handled anonymously, with collective analysis conducted without identifying individual respondents. No psychological or physical harm risks to respondents or researchers were identified.

## **5. Research Results and Discussion**

Out of the surveyed companies, 31.8% have implemented an environmental management system based on the international standard ISO 14001 requirements.

The primary motivation for implementing the Environmental Management System (EMS) according to ISO 14001 was the desire to improve environmental impact management (85.71%). This demonstrates a high level of awareness and commitment from the leadership in the dairy industry. Other significant motivators include ensuring compliance with environmental legal requirements and enhancing the organization's reputation (71.43%). Notably, respondents also highlighted the potential for cost savings (57.14% - definitely yes, and 28.57% - rather yes), reducing waste associated with material consumption (28.57% - definitely yes, and 57.14% - rather yes), and reducing waste generated (28.57% - definitely yes, and 42.86% - rather yes). These factors can significantly contribute to reducing an organization's environmental footprint. Therefore, implementing the ISO 14001 standard as an effective environmental management tool can offer numerous benefits to the organization's leadership and result in positive environmental outcomes stemming from the organization's activities.

Notably, 77.27% of the surveyed organizations set environmental goals for themselves, and the majority successfully achieved them. These organizations primarily assess the effectiveness of their environmental efforts by evaluating the extent to which environmental goals are met (68.18%). Some organizations also practice environmental cost accounting (59.09%) and follow the guidelines provided in ISO 14031 (27.27%). While various tools, such as EMAS, KPIs, ISO/TC 14033, LCA, and ISO 14051, are available for evaluating an organization's environmental performance, their utilization still needs to be improved. None of the surveyed organizations have yet implemented indicators derived from the CSRD directive for ESG reporting.

Among the key environmental objectives set by the surveyed organizations, ensuring compliance with legal requirements and other environmental protection obligations (76.47% - definitely important, 17.65% - important, 5.88% - rather important) and reducing their negative environmental impact (47.06% - definitely important, 47.06% - important, 5.88% - rather important) are of paramount significance. Specific areas such as reducing energy consumption, water usage, and waste generation received equally high ratings regarding importance (35.29%) and importance (64.71%). Other areas of great importance in the surveyed organizations' environmental objectives include reducing environmentally hazardous situations (29.41% - definitely important, 58.82% - important, 17.65% - rather important), improving wastewater quality (35.29% - definitely important, 58.82% - important), enhancing air quality (23.53% - definitely important, 76.47% - important), and reducing emissions of pollutants into the air (23.53% - definitely important, 64.71% - important, 5.88% - rather important, and 5.88% - less important). Environmental objectives were also related to management areas, such as increasing employee environmental awareness (29.41% - definitely important, 58.82% - important, 11.76% - rather important), streamlining communication processes (17.65% - definitely important, 58.82% - important, 17.65% - rather important), and improving the management of environmental aspects (17.65% - definitely important, 58.82% - important, 17.65% - rather important).

Factors influencing the environmental effectiveness of organizations in the dairy industry are categorized into four areas:

- economic factors,
- social factors,
- legal factors,
- organizational factors.

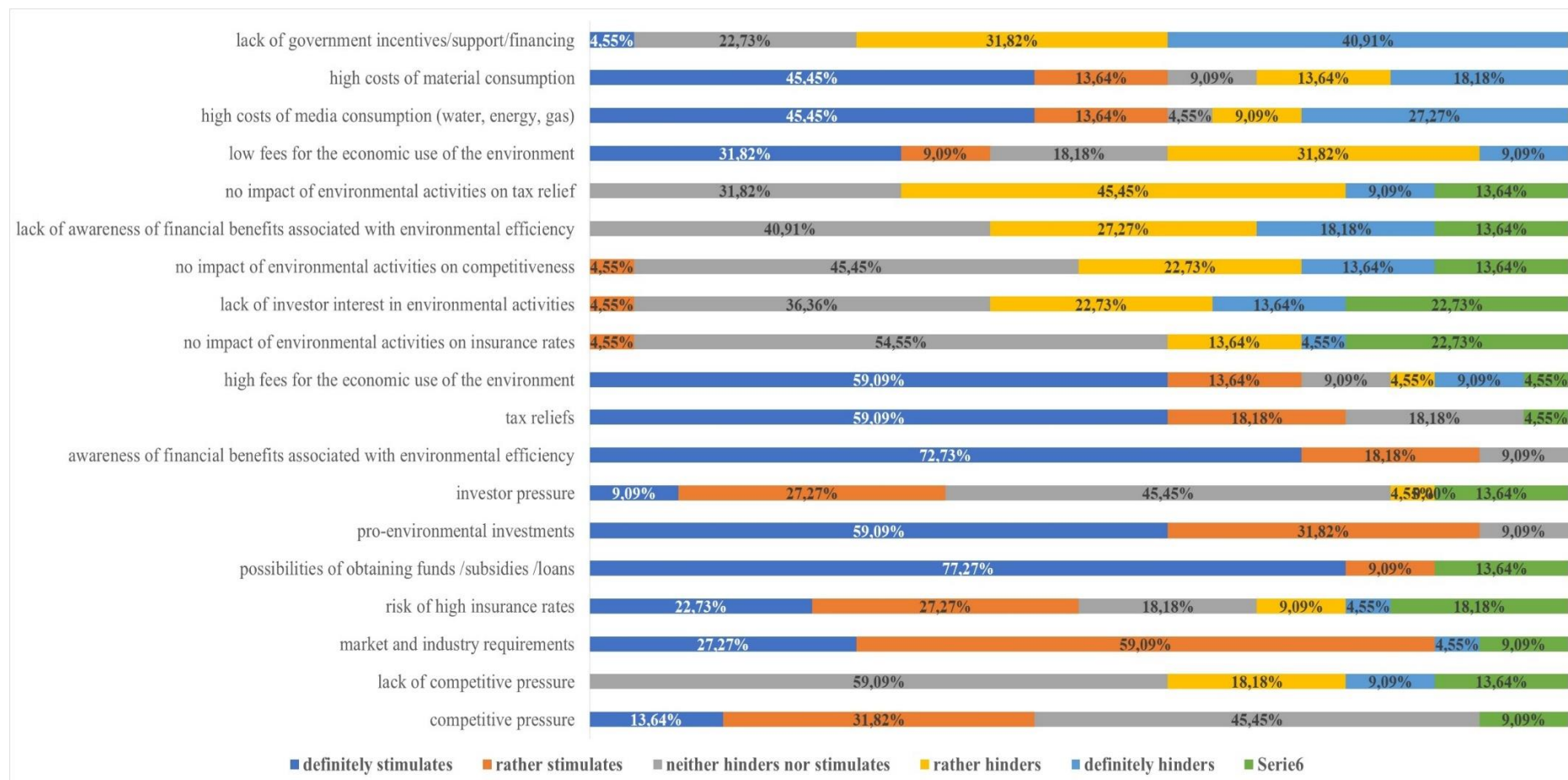
Among the economic factors that significantly stimulate the environmental effectiveness of the surveyed organizations, we can include the opportunity to acquire funds, grants, and loans (77.27%) and the awareness of monetary benefits associated with the environmental efficiency of these organizations (72.73%). The funds are directed towards various eco-friendly investments such as upgrading wastewater treatment plants, new equipment to improve air quality, incorporating renewable energy sources, and new technological solutions to reduce the

organization's environmental impact, enhancing its effectiveness. Particularly in the case of environmental investments, a barrier to absorption in the dairy industry is the limited access to knowledge, advisory support, government backing, and specific incentives such as financial support, suitable training programs, or a tax-friendly policy (Gralak et al., 2022). Among the economic factors that significantly stimulate environmental effectiveness, 59.09% of the representatives from the surveyed organizations included tax incentives, eco-friendly investments, and high fees for environmental usage. These factors encourage organizational leaders to initiate actions to minimise the negative environmental impact, as their absence could lead to substantial financial losses. The environmental effectiveness of the surveyed organizations is also significantly influenced by the high costs associated with material consumption and the use of resources such as water, energy, and gas. This has become particularly important in the recent period due to the conflict in Eastern Europe, which has led to a dramatic increase in resource costs, compelling management to introduce cost-saving solutions. It is important to note that these actions should not compromise the quality of dairy industry products.

Moreover, market requirements (86.36% strongly and somewhat stimulate) also boost organizational environmental effectiveness. This is directly linked to the entire organizational environment and stakeholders influencing the organization's activities. Factors related to the lack of government incentives, insufficient support and funding (72.73%), and the absence of the influence of environmental activities on tax relief (54.54%) can also impact not achieving environmental outcomes. If increased government incentives translated into tax relief, many managers of the surveyed organizations would allocate more resources to activities to minimise the environmental impact, expecting financial benefits. The suspension of EU funding does not promote organizational development and, consequently, the achievement of environmental effectiveness by these organizations. The research results are presented in Figure 1.

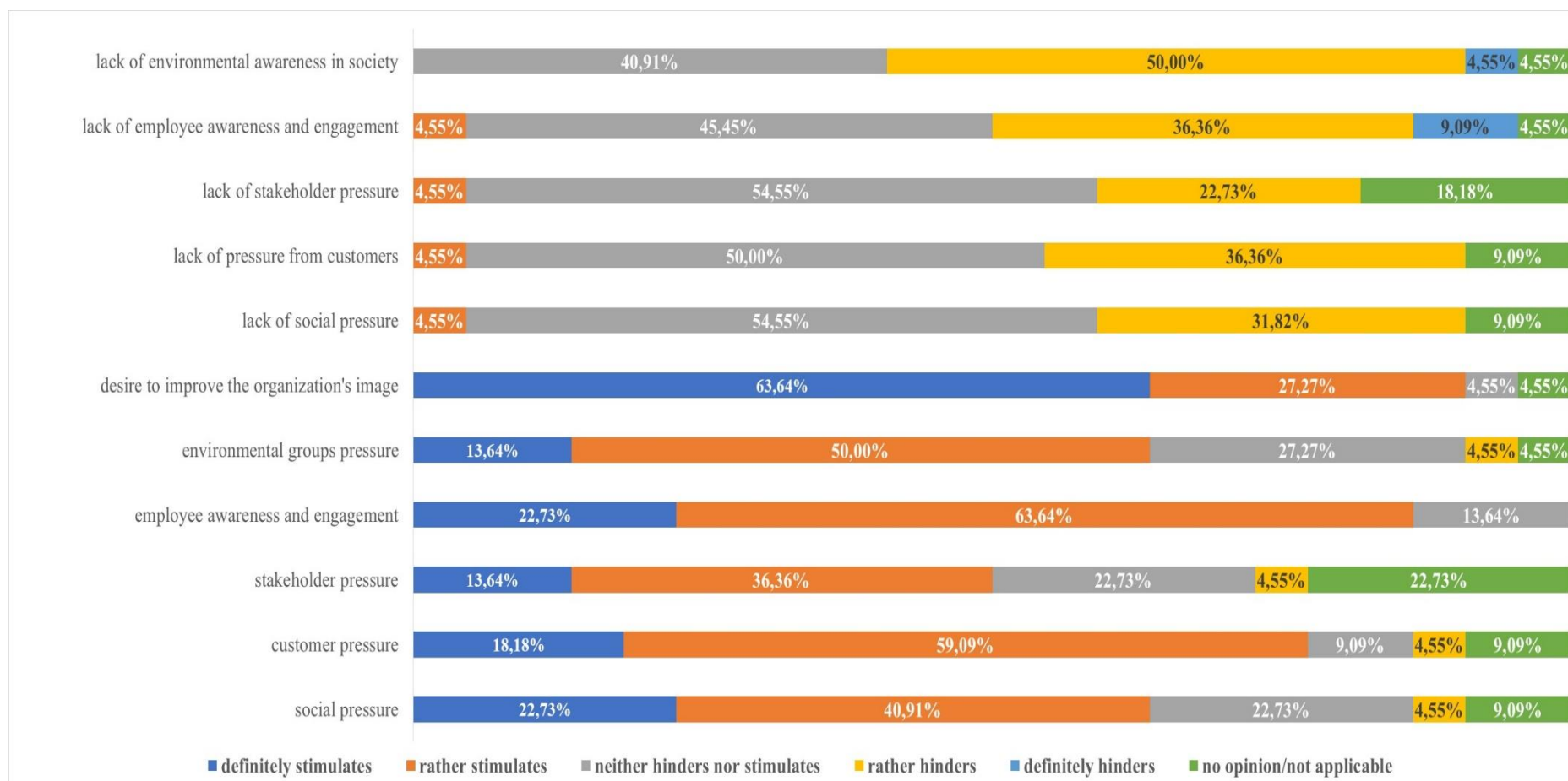
A significant social factor that strongly stimulates the environmental effectiveness of the surveyed organizations is the desire to enhance the organization's reputation (63.64%). Organizational leadership with a substantial environmental impact often makes decisions to improve its reputation, often tied to corporate social responsibility (CSR) activities. In addition, representatives from the surveyed organizations identified several other drivers of environmental effectiveness. These include employee awareness and engagement (22.73% strongly stimulates, 63.64% rather stimulates), societal pressure (22.73% strongly stimulates, 40.91% rather stimulates), customer pressure (18.18% strongly stimulates, 59.09% rather stimulates), and pressure from other stakeholders (13.64% strongly stimulates, 63.64% rather stimulates). These factors are closely related to stakeholders' environmental awareness and environmental activities. However, the need for more environmental awareness among the general public and employees can hinder an organization's environmental effectiveness. The research findings are presented in Figure 2.





**Figure 1.** Economic factors affecting the environmental efficiency of your organization.

Source: own elaboration.

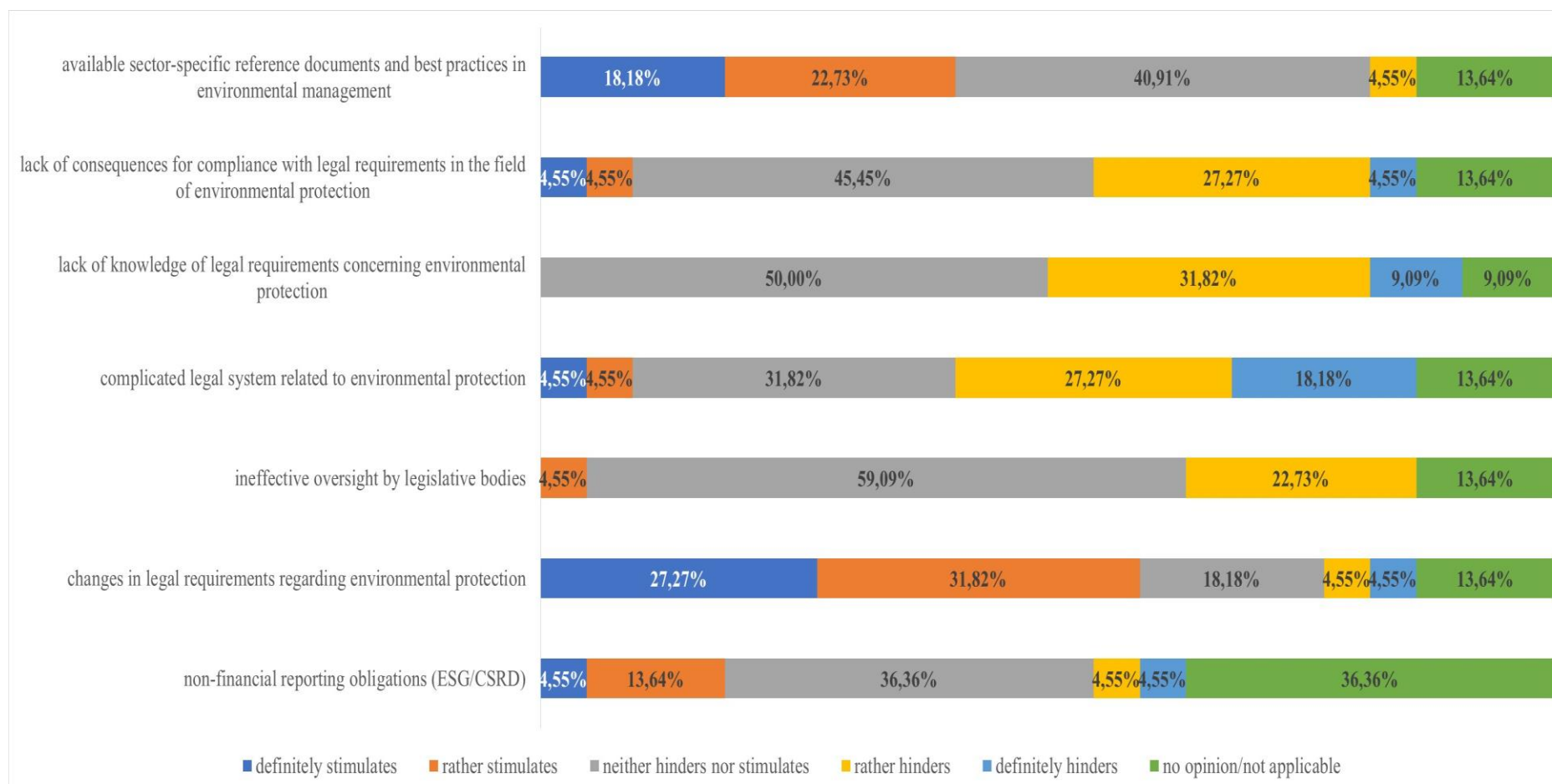


**Figure 2.** Social factors affecting the environmental efficiency of your organization.

Source: own elaboration.

Among the most significant legal factors that stimulate the environmental effectiveness of the surveyed organizations, representatives identified changes in legal requirements regarding environmental protection (22.27% strongly stimulate, 31.82% rather stimulate). Additionally, sector-specific reference documents and best environmental management practices were highlighted (18.18% strongly stimulate, 22.73% rather stimulate). Changes in legal requirements related to environmental protection are oriented towards minimizing the negative impact of organizations on the environment and preventing pollution resulting from their activities. Implementing eco-friendly solutions and investments resulting from legal requirements often translate into economic benefits. Information contained in sector-specific reference documents is precious for organizations. These documents, a result of information exchange organized by the European Commission in compliance with industrial emissions regulations, are tailored for specific activities. They describe techniques, current emission and consumption figures, and methods considered when determining the best available techniques. They also provide details about the Best Available Techniques (BAT) conclusions and any new technologies. These reference documents may greatly assist organizations and contribute to achieving environmental effectiveness. Sector-specific reference documents, developed by the Commission by Regulation (EC) No 1221/2009, are essential for helping sector-specific organizations better address key environmental management aspects. They enable assessment, reporting, and improvement of environmental performance. These documents encompass best environmental management practices, environmental performance indicators, and, where applicable, excellence criteria and assessment systems to classify the level of environmental performance in these sectors. Within sector-specific reference documents related to best environmental management practices, sector-specific environmental performance indicators, and excellence criteria, surveyed organizations can refer to the reference document for the food and beverage production sector (Commission Decision (EU) 2017/1508). This document contains best practices and guidelines for the dairy industry, cheese production, and whey recovery. Unfortunately, the surveyed organizations also identified legal factors that significantly or rather hinder their environmental effectiveness. These factors include a complex legal framework related to environmental protection and a need for familiarity with legal requirements for environmental protection. Respondents also highlighted inconsistencies in complying with environmental legal requirements and ineffective oversight by legislative authorities. The research findings are presented in Figure 3.

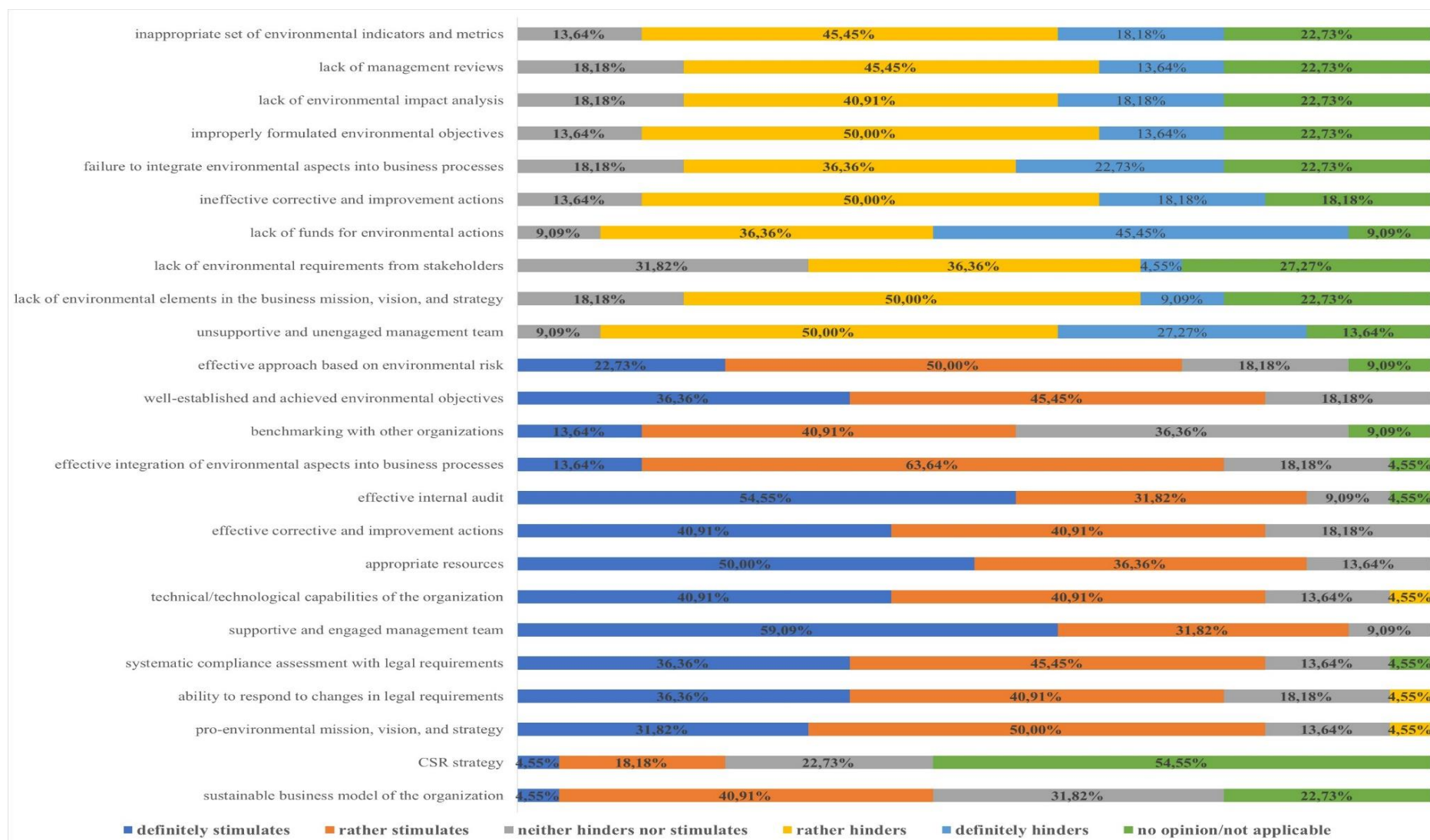
Another group of factors influencing environmental effectiveness is related to management, known as organizational factors. One factor that strongly and somewhat stimulates the environmental effectiveness of the surveyed organizations is a supportive and engaged management team (59.09% strongly stimulate, 31.82% rather stimulate).



**Figure 3.** Legal factors affecting the environmental efficiency of your organization.

Source: own elaboration.

The success of an organization depends significantly on the commitment and leadership of its management team, which plays a pivotal role in driving environmental initiatives. The management of the surveyed organizations demonstrates a high level of engagement in environmental activities, guided by a vision focused on environmental actions and the provision of necessary resources. Therefore, an eco-friendly mission, vision, and strategy have been identified as one of the most important factors stimulating the environmental effectiveness of the surveyed organizations (81.82%). Representatives from the surveyed organizations also identified other drivers of environmental effectiveness, including adequate resources (86.36%), technical and technological capabilities of the organization (81.82%), and well-established and executed environmental goals (81.82%). Adequate resources (human, financial, infrastructure, knowledge, and process operation environment) are crucial factors that could be achieved without environmental results. These resources encompass both the technical and technological capabilities of the organization. The more modern the infrastructure and technology, incorporating environmental impact minimization, the easier it is to achieve environmental outcomes resulting from the organization's activities. Moreover, activities related to environmental management systems were also considered as stimulants to environmental effectiveness. It was noted that effective environmental auditing (86.36%), effective corrective and improvement actions (81.82%), systematic compliance assessment with legal requirements for environmental protection (81.82%), the ability to respond to changes in legal requirements (77.27), effective embedding of environmental aspects in business processes (77.27), and a practical risk-based environmental approach (72.73%) are additional determinants of environmental effectiveness in the surveyed organizations. As part of the research, respondents were asked about factors that hinder environmental effectiveness. The most significant barriers to achieving environmental outcomes are more resources for environmental activities (81.81%) and an unsupportive and unengaged management team (77.27%). Additionally, factors negatively affecting the environmental effectiveness of the surveyed organizations include an inappropriate set of environmental indicators and metrics (63.63%) and actions related to the lack of a systematic approach to environmental management, such as ineffective corrective and improvement actions (68.18%), improperly formulated environmental goals (63.64%), the absence of management reviews (59.09%), the lack of environmental elements in the mission, vision, and business strategy (59.09%), and the absence of environmental impact assessments (58.28%). An effective environmental management system allows organizations to achieve significantly greater environmental outcomes. A graphical representation of the organizational factors influencing environmental effectiveness is presented in Figure 4.



**Figure 4.** Organizational factors affecting the environmental efficiency of your organization.

Source: own elaboration.

Based on the research findings, several recommendations can be made to improve the environmental effectiveness of the dairy products industry. Firstly, government support. The government should provide support, including incentives and knowledge sharing, to facilitate eco-friendly investments within the industry (Alem, 2023) to expedite the adoption of sustainable technologies. For example, the United States dairy industry formed The Dairy Alliance and has set aggressive environmental sustainability goals to achieve greenhouse gas neutrality, optimize water usage, and improve water quality by 2050 (The Dairy Alliance).

Secondly, employee engagement. Employee engagement can be an effective way to promote sustainable practices within the dairy industry. For instance, dairy farmers can be encouraged to adopt sustainable practices through training and education programs. Organizations should invest in ongoing environmental awareness programs and motivation initiatives to involve all employees in eco-conscious practices, essential for a holistic approach to environmental responsibility. This shall also include knowledge-sharing and benchmarking opportunities. The industry should focus on continuous compliance with environmental regulations and sector-specific reference documents. Additionally, organizations should share knowledge and collaborate to align with best practices and lessons learned from successful sustainability initiatives (Van Slyke et al., 2021).

Thirdly, the emphasis should be placed on implementing effective environmental management systems based on a risk-based approach. Leadership teams should commit to resource allocation and adopting innovative, eco-friendly technologies to achieve better environmental outcomes. Effective environmental management practices can help reduce the dairy industry's environmental impact. While implementing the environmental management system, organizations shall take a holistic approach considering the entire value chain of the dairy industry, from feed production to milk processing and distribution. The dairy industry can benefit from adopting a circular economy approach, which reduces waste and maximises resource efficiency (Oliveira et al., 2021).

One limitation of the study is its geographical scope, which is limited to Poland. To gain a more comprehensive understanding of the environmental effectiveness of the dairy industry, future research could expand its scope to include multiple countries or regions, allowing for cross-country comparisons and insights into different regulatory environments and cultural influences. The study was focused on the dairy industry's environmental effectiveness and might not cover all sustainability-related aspects. Future research could explore broader aspects of sustainability, such as social and economic sustainability, to provide a more holistic understanding of the industry's impact.

In terms of future research, several ways are worth considering. Firstly, investigating the long-term impact of environmental management systems such as ISO 14001 on the dairy industry's environmental performance could provide valuable insights. Additionally, exploring the potential for circular economy practices in the dairy sector could be an area for further investigation. Understanding how external factors, such as global economic conditions or

international trade agreements, affect the environmental practices of the dairy industry is another promising path for future research. Such studies could provide insights into how external forces influence the industry's environmental effectiveness.

## 6. Conclusions

Research has shown that various factors influence organisations' environmental effectiveness, stimulating or hindering it. In light of the comprehensive examination of factors influencing environmental effectiveness within the dairy products industry, this study has uncovered essential implications for the industry and individual organizations. To enhance environmental effectiveness, organizational leadership should focus on improving environmental activities in the four mentioned areas because they are closely interconnected. The dairy products industry faces a dynamic landscape with increasing environmental standards and growing societal demands for eco-conscious products.

Our research highlights several key findings. The study identifies economic, social, legal, and organizational factors as key influencers of environmental effectiveness in the dairy industry.

- Economic factors: Access to funding, grants, and loans for eco-friendly investments is essential for modernization and sustainability in the dairy sector. Securing financial support significantly enhances environmental effectiveness. Limited access to knowledge, government support, and incentives remains a barrier.
- Legal factors: Compliance with increasing environmental regulations and sector-specific reference documents is crucial for enhancing environmental effectiveness.
- Social factors: Environmental consciousness, employee engagement, and societal pressure are powerful drivers for improving environmental effectiveness. Promoting awareness and motivation among employees is crucial.
- Organizational factors: Effective environmental management systems, supported by committed leadership, resource allocation, and innovative, eco-friendly technologies, are at the core of environmental effectiveness. A systematic, risk-based approach to environmental management is recommended.

The research is limited to Poland, which affects its geographical scope. Future research could expand to include multiple countries or regions for cross-country comparisons. The study focused on environmental effectiveness and may not cover all sustainability-related aspects. Future research could explore broader aspects of sustainability.



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## FUNDAMENTAL ACCOUNTING PRINCIPLES IN POLISH AUTHORS' PUBLICATIONS

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**Purpose:** This article aims to identify, systematize, and assess the scientific achievements of Polish authors on the fundamental accounting principles as well as to indicate the directions of further research in this field.

**Design/methodology/approach:** The study has been carried out using a structured literature review in the form of a so-called rapid review. The method of meta-analysis was also used as an aid in relation to the collection of literature assembled as a result of a systematic review. Then, the analysis of content of this collection of literature has been carried out to answer the research questions posed.

**Findings:** The review results indicate that the principles of true and fair view, going concern, and prudence are at the center of Polish authors' attention. Polish authors perceive and discuss the terminological inaccuracy in defining the concept of "fundamental accounting principles" and particular accounting principles. Polish researchers still have no consensus regarding the catalog of fundamental accounting principles or their hierarchy and classification. They also notice that while the going concern, substance over form, and accrual basis principles got significance, the role of the principles of prudence, matching, realization, and historical cost has decreased. The conducted analysis also shows that Polish authors consider the fundamental accounting principles concerning multiple areas of financial reporting and accounting but also go beyond them.

**Research limitations/implications:** The study's limitations result from the eligibility parameters adopted in the structured literature review, analyzed databases, and the author's subjectivity in the articles' qualification.

**Originality/value:** This article is the first comprehensive summary of the scientific achievements of the Polish authors on the fundamental accounting principles.

**Keywords:** structured literature review, SLR, fundamental accounting principles, Polish authors.

**Category of the paper:** Literature review.

## 1. Introduction

Accounting, which is a specific system of collecting, processing, and transmitting information, uses specific procedures, methods, and principles relating, in particular, to the valuation and presentation of data on the economic situation of an entity and its financial result (Kuzior, 2020). Due to their timeless nature, these principles are applied, albeit in varied degrees, in all accounting systems and are in some manner incorporated into legal regulations as being superior to them. They serve as the theoretical basis for accounting and have an impact on the final financial statements' credibility, integrity, and usefulness (Kuzior et al., 2018). Accounting principles are of interest not only to practitioners and standard-setting agencies but also to academic circles and theorists, including Polish ones, due to the importance of their role in providing high-quality financial information to users of financial reporting. Accounting principles are defined, categorized, hierarchized, and examined in many ways in the Polish literature on the subject regarding their impact on various areas of recording business operations and preparing financial statements. Changes in the significance and importance of individual accounting principles, as well as their implementation and interpretation, are also discussed as a result of changes in the information demands of reporting information recipients (Głębocka, 2016b; Kuzior et al., 2018). However, no publication has yet been published that comprehensively summarizes Polish publication achievements in this area. As a result, it becomes appropriate to outline the publication accomplishments of Polish authors in this field.

Therefore, the aim of this article is to identify, systematize, and assess the scientific achievements of Polish authors on the fundamental accounting principles as well as to indicate the directions of further research in this field.

Fulfilling the above-formulated goal involved answering the following four research questions:

- 1) What fundamental accounting principles have received the most attention in the research done so far by Polish authors?
- 2) How do Polish authors define and hierarchize fundamental accounting principles?
- 3) Concerning which areas of accounting and financial reporting do Polish authors raise the issue of fundamental accounting principles?
- 4) What directions of evolution of the importance and rank of individual fundamental accounting principles have Polish authors noticed?

The following section of the article describes the research approach used and then offers the findings of the meta-analysis and content analysis of the set of publications under consideration. The study ends with conclusions summarizing and discussing the acquired results and indicating future research directions. Limitations due to assumptions made in the research approach were also identified.



## 2. Research methods

The study was carried out using a structured (systematic) literature review (SLR), which is becoming a more widely used approach for conducting a reliable literature review in numerous fields of science (Tuszkiewicz, Maruszewska, 2021). Because a systematic literature review should, in principle, be completed by at least two researchers, and the author did the study alone, the so-called rapid review was chosen as the research approach<sup>1</sup>.

Primarily, to identify potential references, the following three electronic databases were reviewed:

- BazEkon,
- EBSCOhost, and
- ProQuest.

The keyword “zasady rachunkowości” was input into these databases. According to the author, this phrase is specific and broad enough to allow searching for as many relevant literature articles as possible. The collected findings were then downloaded to Zotero software, which offers bibliographic source management, including organization. The bibliography of the literature gathered thus far was also evaluated in order to supplement the collection with possible positions that could be omitted while searching databases with the use of selected keyword. The collection of publications was also completed with papers already known to the author and chosen through the so-called preliminary search. Duplicates in the gathered literature were eliminated. Then, a database comprising 503 literature records was obtained (figure 1).

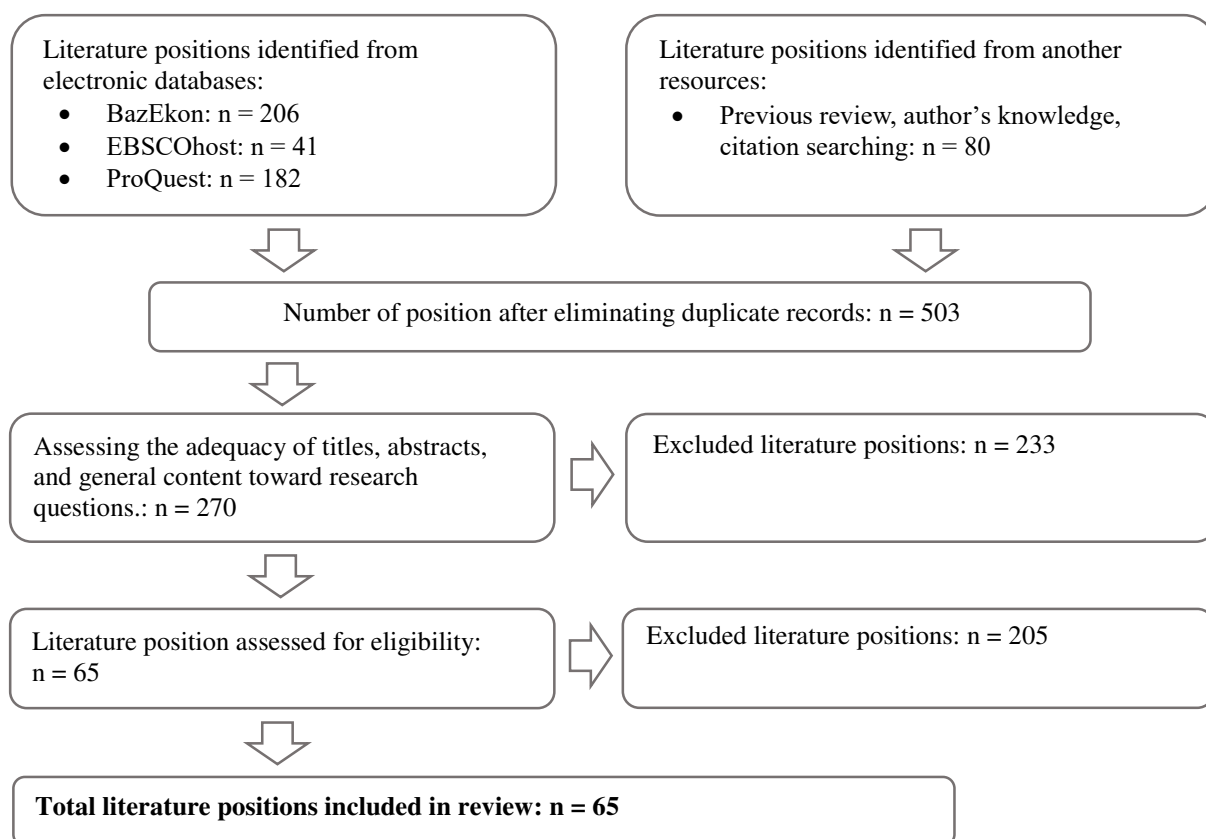
The next step carried out an exclusion analysis, taking into account the following eligibility parameters:

- publications is a scientific article published in a review Polish or foreign journals,
- at least one of the authors is Polish,
- article was written in Polish or English,
- fundamental accounting principles are the main or one of the main threads of publication and
- the author had access to the full text of the publication.

The exclusion analysis was divided into two stages, and diagram 1 illustrates its course. The first stage involved assessing the adequacy of titles, abstracts, and general content toward research questions. Then, literature positions were assessed for the above-specified eligibility criteria meeting. Only articles that simultaneously met all eligibility criteria entered the final a collection of publications. As a result, collection of 65 publications was obtained.

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<sup>1</sup> R. Lenart-Gansiniec (2021) and Mazur, Orłowska (2018) write more about the structured literature review and its specific varieties.



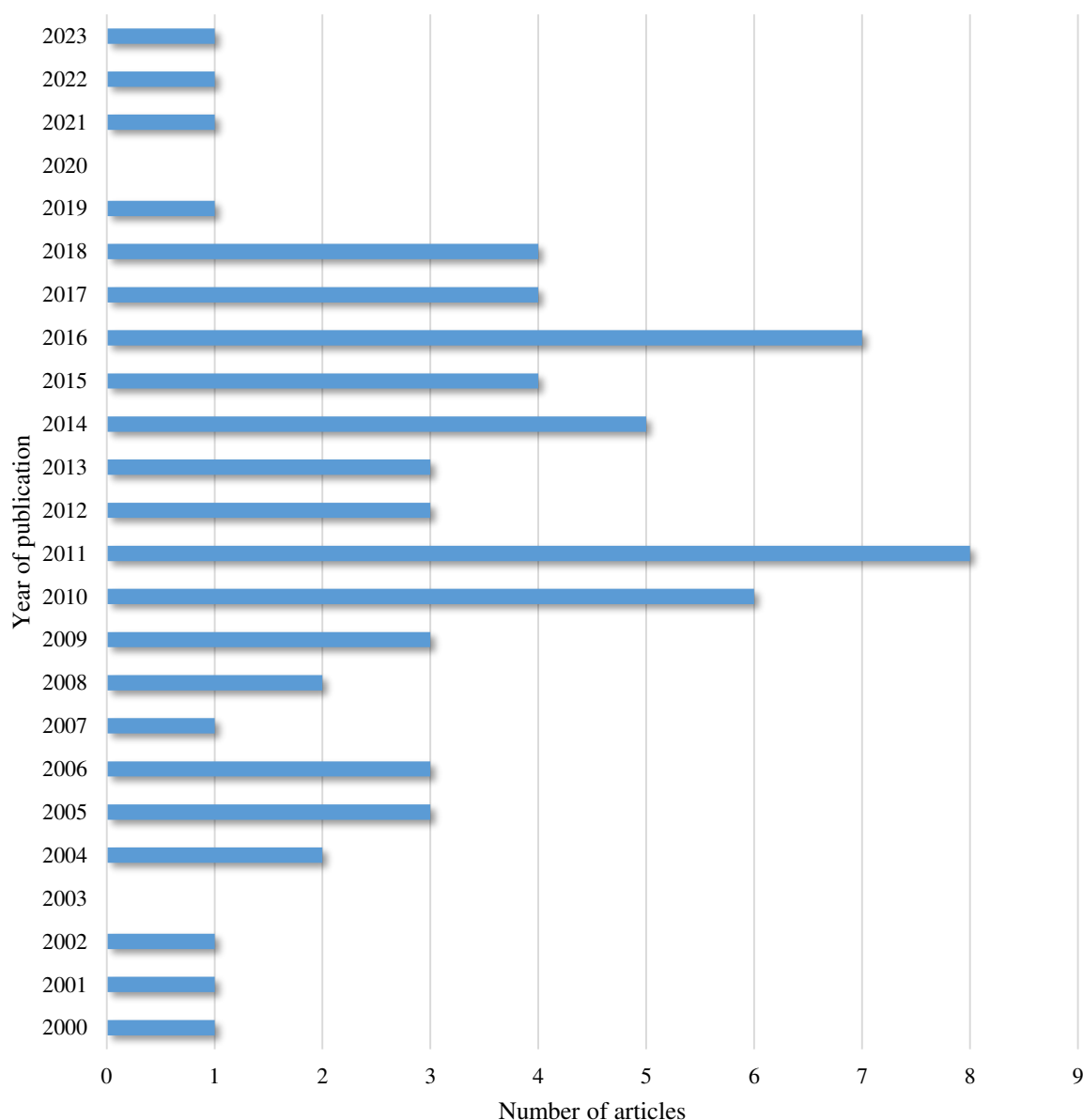
**Figure 1.** PRISMA flow diagram.

Source: Own study based on (Mazur, Orłowska, 2018).

### 3. Results – meta-analysis

The articles that qualified for the systematic literature review were analyzed using various quantitative criteria. The first one was the year of publication (figure 2).

The data presented in figure 2 show that the first article on fundamental accounting principles appeared in 2000. The most significant interest in this topic occurred in the years 2010-2011 and 2014-2018 – in this period, more than half of the articles on the issues discussed were published, including its most remarkable number in 2011. Since 2019, there has been a decrease in the number of publications relating to the analyzed topic to one publication per year, for which there is no apparent cause, as it could be due to both a decrease in interest in the topic or its "exhaustion" as well as the adopted eligibility parameters, which could limit the review's results. There were also some years in the studied period where not a single publication on fundamental accounting concepts was published – these were the years 2003 and 2020. On average, 2 to 3 publications were published annually.



**Figure 2.** Number of articles published per year.

Source: own study.

Most papers (approximately 92%) were published in Polish language and in Polish journals. Only 5 articles were published in English, of which 4 papers appeared in Polish journals (2 articles in the “Zeszyty Naukowe Uniwersytetu Ekonomicznego w Poznaniu”, 1 article in “Financial Sciences. Nauki o Finansach”, and 1 article in the “Olsztyn Economic Journal”) and one paper in a foreign journal (“European Accounting Review”). Table 1 presents a detailed breakdown of the number of papers in individual journals.

**Table 1.***Breakdown of the number of articles in individual journals*

Journal name	Number of articles
<b>Polish journals</b>	
Zeszyty Teoretyczne Rachunkowości	19
Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu	8
Studia Ekonomiczne	6
Zeszyty Naukowe. Uniwersytet Ekonomiczny w Poznaniu	6
Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie/Akademii Ekonomicznej w Krakowie	4
Finanse, Rynki Finansowe, Ubezpieczenia	3
Studia Oeconomica Posnaniensia	3
Zeszyty Naukowe Uniwersytetu Szczecińskiego. Finanse, Rynki Finansowe, Ubezpieczenia	2
Other (which contain 1 publication)	13
<b>Foreign journals</b>	
European Accounting Review	1

Source: own study.

The data shown in Table 1 indicate a general dispersion of articles on fundamental accounting principles among various scientific journals. The unsurpassed dominance of “Zeszyty Teoretyczne Rachunkowości” in terms of the quantity of articles published is also obvious – about every third item in the evaluated literature was published there. In quite distant second place are “Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu”, which published around 12% of the articles. The third place is taken *ex aequo* by “Studia Ekonomiczne” and “Zeszyty Naukowe Uniwersytetu Ekonomicznego w Poznaniu”, which published nearly 9% of the publications. In the remaining journals, the vast majority (as many as 73% of the journals) published one article.

A. Kaczmarczyk and I. Kumor published the largest number of articles on fundamental accounting principles. The first author released 4 publications and the second author – 3 publications (including one in collaboration with L. Poniowska). The remaining authors published one or two articles.

Table 2 presents the results of the analysis of the affiliation of the authors of the publications qualified for the systematic literature review. The first three research centers, which lead in the count of articles on fundamental accounting principles, are sequentially Poznań University of Economics and Business (17% of publications), Wrocław University of Economics and Business (14% of publications), and the University of Economics in Katowice (12% of publications). The last two of the above-mentioned academic centers were indicated as affiliation by the earlier mentioned authors with the largest amount of published articles, respectively A. Kaczmarczyk and I. Kumor. There was also one article in the studied literature collection whose author did not provide affiliation and one whose author identified a foreign affiliation (i.e. School of Management and Languages, Heriot-Watt University, Edinburgh).

**Table 2.***Breakdown of the affiliation of the analyzed articles' authors*

Affiliation	Number of articles
Poznań University of Economics and Business	11
Wrocław University of Economics and Business	9
University of Economics in Katowice	8
University of Łódź	6
Kraków University of Economics	5
SGH Warsaw School of Economics	4
University of Gdańsk	4
University of Szczecin	4
Warsaw University of Life Sciences	2
Other (from which authors published only 1 article)	12
No affiliation	1

Source: own study.

The results of the quantitative analysis of the Polish authors' publications collection on the fundamental accounting principles show a general dispersion of articles among various scientific journals and academic centers. They also indicate domination of articles written in Polish and published in "Zeszyty Teoretyczne Rachunkowości".

#### 4. Results – content analysis

When analyzing the content of the collection of Polish authors' publications on fundamental accounting principles, the nature of the articles was first examined. This examination showed that up to fifty articles were strictly theoretical, and only two were strictly empirical. The remaining part (13 articles) are publications of an intermediate character - they include both a developed theoretical part and an empirical part enriching the conclusions resulting from it. Moreover, one of the articles classified as strictly theoretical presented the main assumptions and conclusions resulting from the author's previously defended dissertation.

The next step of the content analysis of the set of publications qualified for the systematic literature review allowed for identifying fundamental accounting principles that remain the center of the Polish scientific community's attention. Table 3 presents the breakdown of the articles that treat on particular fundamental accounting principles. This table also includes the division of articles into three groups, i.e. theoretical, empirical and theoretical-empirical.

**Table 3.***Breakdown of the articles on particular fundamental accounting principles*

<b>Fundamental accounting principle</b>	<b>Theoretical articles [T]</b>	<b>Empirical articles [E]</b>	<b>Theoretical-empirical articles [T/E]</b>	<b>Number of articles</b>
True and fair view	Artienwicz (2008), Bereżnicka (2016), Burchart & Soldevila de Monteys (2017), Cieciora (2011), Garstecki (2012), Grzegorek (2005), Gut (2011), Janus (2011), Jezierska (2008), Kaczmarczyk (2011), Kaczmarczyk (2015), Kociołek (2019), Krasodomska (2010), Krzywda (2007), Kumor (2014), Matuszak (2013), Michalak (2004), Nierzwicka (2001), Nowak (2014), Remlein (2010), Rówińska (2016), Rówińska & Zadora (2012), Sawicka (2009), Sikorska (2005), Soczówka (2000), Spoz (2015), Świetla (2011), Walińska (2002), Walińska & Jędrzejewski (2009), Wrona (2006)		Ignatowski (2017), Kaczmarczyk (2018), Kaczurak-Kozak (2011), Kosmala (2005), Piechocka-Kałużna (2018), Stępień (2014)	<b>Total 36,</b> including: T: 30 E: --- T/E: 6
Going concern	Baran (2006), Bereżnicka (2016), Burchart & Soldevila de Monteys (2017), Czupryńska (2017), Głębocka (2016a), Grzegorek (2005), Jezierska (2008), Koczar (2017), Kondraszuk (2011), Krzywda (2006), Krzywda (2007), Kumor (2014), Kumor (2016), Nowak (2010), Remlein (2010), Rówińska & Zadora (2012), Soczówka (2000), Szmerekiet (2004), Świetla (2011), Walińska (2002), Walińska & Jędrzejewski (2009), Wierzbińska (2012), Wrona (2006), Zuchewicz (2009), Zyznarska-Dworczak (2010)		Chrostowska (2023), Kaczmarczyk (2018), Kaczurak-Kozak (2011), Piróg (2016), Stępień (2014), Szczepankiewicz (2013a), Szczepankiewicz (2013b)	<b>Total 32,</b> including: T: 25 E: --- T/E: 7
Prudence	Baran (2006), Bareja (2018), Bereżnicka (2016), Burchart & Soldevila de Monteys (2017), Głębocka (2016b), Grzegorek (2005), Hońko (2010), Jezierska (2008), Kaczmarczyk (2011), Kaczmarczyk (2021), Kociołek (2019), Krasodomska (2010), Krzywda (2007), Kumor (2014), Łazarowicz (2015), Michalak (2004), Remlein (2010), Rówińska & Zadora (2012), Sawicka (2009), Soczówka (2000), Szmerekiet (2004), Świetla (2011), Walińska (2002), Walińska & Jędrzejewski (2009), Wierzbińska (2012), Wrona (2006)	Klimczak & Michalak (2014)	Kumor & Poniatowska (2018), Łakomiak (2010), Stępień (2014)	<b>Total 30,</b> including: T: 26 E: 1 T/E: 3

Cont. table 3.

Accrual basis	Baran (2006), Bereżnicka (2016), Grzegorek (2005), Jezierska (2008), Koczar (2017), Kondraszuk (2011), Krzywda (2006), Krzywda (2007), Kumor (2014), Maćkowiak (2014), Remlein (2010), Soczówka (2000), Szmerekietta (2004), Świetła (2011), Walińska (2002), Wierzbińska (2012), Wrona (2006)	Klimczak & Michalak (2014)	Kumor & Poniatowska (2018), Łakomiak (2010), Stępień (2014)	<b>Total: 21,</b> including: T: 17 E: 1 T/E: 3
Matching	Bereżnicka (2016), Burchart & Soldevila de Monteys (2017), Grzegorek (2005), Jezierska (2008), Krzywda (2007), Kumor (2014), Remlein (2010), Rówińska & Zadora (2012), Sawicka (2009), Soczówka (2000), Świetła (2011), Walińska (2002), Wierzbińska (2012)		Gos & Hońko (2016), Kumor & Poniatowska (2018), Łakomiak (2010), Stępień (2014)	<b>Total: 17,</b> including T: 13 E: --- T/E: 4
Materiality	Baran (2006), Burchart & Soldevila de Monteys (2017), Jezierska (2008), Koczar (2017), Krzywda (2007), Soczówka (2000), Szmerekietta (2004), Świetła (2011), Wierzbińska (2012), Wrona (2006)	Gos (2022)	Kaczurak-Kozak (2011), Kumor & Poniatowska (2018), Stępień (2014)	<b>Total: 15,</b> including: T: 11 E: 1 T/E: 3
Consistency	Bereżnicka (2016), Burchart & Soldevila de Monteys (2017), Jezierska (2008), Kasperowicz (2011), Krzywda (2006), Krzywda (2007), Remlein (2010), Soczówka (2000), Szmerekietta (2004), Świetła (2011), Walińska (2002), Wierzbińska (2012)		Kaczurak-Kozak (2011), Stępień (2014)	<b>Total: 14,</b> including: T: 12 E: --- T/E: 2
Substance over form	Baran (2006), Jezierska (2008), Koczar (2017), Krzywda (2007), Remlein (2010), Sawicka (2009), Świetła (2011), Walińska (2002), Walińska & Jędrzejewski (2009), Wierzbińska (2012)		Łakomiak (2010)	<b>Total: 11,</b> including: T: 10 E: --- T/E: 1
Periodicity	Jezierska (2008), Soczówka (2000), Świetła (2011), Wrona (2006)		Kumor & Poniatowska (2018)	<b>Total: 5,</b> including T: 4 E: --- T/E: 1
Non-compensation	Burchart & Soldevila de Monteys (2017), Jezierska (2008), Krzywda (2007), Świetła (2011)		Stępień (2014)	<b>Total: 5,</b> including: T: 4 E: --- T/E: 1
Cash basis	Grzegorek (2005), Koczar (2017), Maćkowiak (2014), Soczówka (2000)			<b>Total: 4,</b> including: T: 4 E: --- T/E: ---
Realization	Jezierska (2008), Krzywda (2007), Szmerekietta (2004)		Łakomiak (2010)	<b>Total: 4,</b> including T: 3 E: --- T/E: 1

Cont. table 3.

Individual valuation	Krzywda (2007), Szmerekietą (2004)		Stępień (2014)	<b>Total: 3,</b> including T: 2 E: --- T/E: 1
Historical cost	Jezierska (2008), Kumor (2014), Szmerekietą (2004)			<b>Total: 3,</b> including T: 3 E: --- T/E: ---
Economic entity	Koczar (2017), Soczówka (2000), Wrona (2006)			<b>Total: 3,</b> including T: 3 E: --- T/E: ---
Objectivity	Rówińska & Zadora (2012), Szmerekietą (2004)			<b>Total: 2,</b> including: T: 2 E: --- T/E: ---
Primacy (applicable in Germany)	Krasodomska (2010), Szmerekietą (2004)			<b>Total: 2,</b> including: T: 2 E: --- T/E: ---

Source: own study.

The first most frequently described, analyzed, and cited fundamental accounting principle is the true and fair view principle, which appears in as many as 36 articles, i.e., in more than half of the articles included in the investigated publications' set. This is not surprising because – as it is indicated by many authors referring to it, including M. Nierzwicka (2001) and N. Artienwicz (2008) – this principle is primary and is the main concept of accounting identified with its purpose, which is to generate objective and trustworthy information about an economic entity. This principle appears in 30 theoretical articles and 6 theoretical-empirical articles. Discussing this principle, the Polish authors point out (among others) the lack of consensus in defining and translating this principle into Polish<sup>2</sup>. They also present its definition in a broader and narrower sense and refer to difficulties in applying this principle.

The second place took the going concern principle, which appears in 32 articles, including 25 of a theoretical nature and 7 of a theoretical-empirical nature. The Polish authors that refer to this principle investigate mainly the premises suggesting the risk of losing the entity's ability to perform operations, including those related to the COVID-19 pandemic. E. Walińska and S. Jędrzejewski (2009) also raised the issue of the suitability of accounting principles applicable in the balance law for those entities that are no longer capable of continuing their operating activities. B. Zyznarska-Dworczak (2010) pointed out that although both in "The Conceptual Framework for Financial Reporting", International Accounting Standard (IAS) 1 "Presentation

<sup>2</sup> The true and fair view principle originates from British commercial law (see N. Artienwicz (2008), R. Ignatowski (2017), and A. Spoz (2015)).



of Financial Statements”, and Polish Accounting Act the going concern principle plays a crucial role, those regulations place this principle differently in relation to the other principles. This first regulation defines the going concern principle as the “fundamental premise of financial statement preparation and presentation” while the last two generally position this principle on the same level as other principles and qualitative characteristics of financial statements.

The third place took the prudence principle, which appears in 30 articles, including 26 theoretical, 1 empirical, and 3 theoretical-empirical. The articles on this principle primarily discuss the turbulent evolution of its application over the years (especially in the International Financial Reporting Standards (IFRS)) and its current role in accounting and financial reporting. A. Kaczmarczyk (2021) highlights the visible marginalization of this principle in the Polish Accounting Act in the accounting of micro- and small entities and its “degradation” in the International Financial Reporting Standards from a superior principle to a feature supporting the neutrality and credibility of financial statements. K. Bareja (2018) points out the selectivity currently occurring in IFRS in applying this principle, which is related to the simultaneous functioning of the fair value valuation model for some assets and the historical cost model for others.

The collection of the Polish authors’ publications was also examined in terms of thematic areas in which the authors described fundamental accounting principles. It was assumed that a given article might be classed under more than one theme. As a result, 12 main thematic areas and 26 detailed thematic areas were identified. Table 4 shows the breakdown of the articles that relate to those particular themes with the division of articles into three groups, i.e., theoretical, empirical, and theoretical-empirical.

**Table 4.**

*Breakdown of the thematic areas considered in the context of fundamental accounting principles*

Thematic area		Theoretical articles [T]	Empirical articles [E]	Theoretical-empirical articles [T/E]	Number of articles
Fundamental accounting principles	General definition, terminology	Artienwicz (2008), Cieciora (2010), Garstecki (2012), Grzegorek (2005), Krzywda (2006), Krzywda (2007), Kumor (2014), Łazarowicz (2015), Matuszak (2013), Nowak (2010), Nowak (2014), Remlein (2010), Sikorska (2005), Soczówka (2000), Spoz (2015), Szczepańska (2015), Wierzbńska (2012)		Gos & Hońko (2016), Ignatowski (2017), Kosmala (2005), Piechocka-Kałużna (2018)	<b>Total 21, including:</b> T: 17 E: --- T/E: 4

Cont. table 4.

	Hierarchy, classification and relations	Baran (2006), Bereżnicka (2016), Grzegorek (2005), Janus (2011), Jezierska (2008), Kaczmarczyk (2011), Koczar (2017),		Stępień (2014), Szczepankiewicz (2013a)	<b>Total 21, including:</b> T: 18 E: --- T/E: 2
	Hierarchy, classification and relations	Krzywda (2006), Krzywda (2007), Kumor (2014), Remlein (2010), Szczepańska (2015), Szmerekiet (2004), Świetla (2011), Walińska (2002), Wierzbńska (2012), Wrona (2006), Zuchewicz (2009)			
	History and evolution	Artienwicz (2008), Bareja (2018), Bereżnicka (2016), Głębocka (2016b), Hońko (2010), Jezierska (2008), Kaczmarczyk (2021), Kociołek (2019), Koczar (2017), Łazarowicz (2015), Maćkowiak (2014), Nierzwicka (2001), Remlein (2010), Sikorska (2005), Spoz (2015), Walińska (2002), Walińska & Jędrzejewski (2009), Wierzbńska (2012)		Gos & Hońko (2016), Ignatowski (2017), Kosmala (2005) Piechocka-Kałużna (2018)	<b>Total: 22, including:</b> T: 18 E: --- T/E: 4
	Various countries	Burchart & Soldevila de Monteys (2017), Koczar (2017), Kaczmarczyk (2011), Kaczmarczyk (2021), Krasodomska (2010), Sikorska (2005), Szmerekiet (2004)	Klimczak & Michalak (2014)	Kosmala (2005), Piechocka-Kałużna (2018)	<b>Total: 10, Including</b> T: 7 E: 1 T/E: 2
Financial reporting	Essence and purpose	Baran (2006), Janus (2011), Kaczmarczyk (2011), Krzywda (2006), Matuszak (2013)			<b>Razem: 5, w tym:</b> T: 5 E: --- T/E: ---
	Qualitative characteristics	Baran (2006), Bareja (2018), Cieciora (2011), Głębocka (2016b), Janus (2011), Kaczmarczyk (2021), Kasperowicz (2011), Krzywda (2006), Krzywda (2007), Nowak (2014), Remlein (2010), Rówińska & Zadora (2012), Sikorska (2005), Szczepańska (2015), Świetla (2011), Zuchewicz (2009), Zyznarska-Dworczak (2010)	Gos (2022)	Piechocka-Kałużna (2018)	<b>Razem: 19, w tym:</b> T: 17 E: 1 T/E: 1

Cont. table 4.

	Information expectations of financial statements users	Baran (2006), Bereżnicka (2016), Jezierska (2008), Matuszak (2013), Remlein (2010), Rówińska & Zadora (2012), Spoz (2015), Wrona (2006)		Piróg (2016)	<b>Total: 9,</b> including: T: 8 E: --- T/E: 1
	Valuation in general	Bareja (2018), Bereżnicka (2016), Głębocka (2016b), Hońko (2010), Matuszak (2013), Michalak (2004), Rówińska (2016), Rówińska & Zadora (2012), Spoz (2015), Zyznarska-Dworczak (2010)			<b>Total: 10,</b> including T: 10 E: --- T/E: ---
	Fair value valuation	Bereżnicka (2016), Rówińska (2016), Rówińska & Zadora (2012), Wierzbńska (2012)			<b>Total: 4,</b> including T: 4 E: --- T/E: ---
	Accruals and deferrals			Gos & Hońko (2016), Kumor & Poniatowska (2018)	<b>Total: 2,</b> including T: --- E: --- T/E: 2
	Revenues			Łakomiak (2010)	<b>Total: 1,</b> including T: --- E: --- T/E: 1
	Financial result	Hońko (2010), Kasperowicz (2011), Rówińska (2016), Rówińska & Zadora (2012)		Stępień (2014)	<b>Total: 5,</b> including: T: 4 E: --- T/E: 1
	Non-current assets held for sale			Kaczmarczyk (2018)	<b>Total: 1,</b> including T: --- E: --- T/E: 1
	Goodwill	Kumor (2014), Sawicka (2009)			<b>Total: 2,</b> including T: 2 E: --- T/E: ---
	Leasing	Janus (2011)			<b>Total: 1,</b> including T: 1 E: --- T/E: ---

Cont. table 4.

	Long-term contracts	Kasperowicz (2011)			<b>Total: 1,</b> including T: 1 E: --- T/E: ---
	Transactions between affiliates	Gut (2011)			<b>Total: 1,</b> including T: 1 E: --- T/E: ---
	Impairment of assets	Michalak (2004)			<b>Total: 1,</b> including T: 1 E: --- T/E: ---
Accounting and financial reporting of specific entities	Entities providing long-term services	Kasperowicz (2011)			<b>Total: 1,</b> including T: 1 E: --- T/E: ---
	Entities from the public sector	Maćkowiak (2014), Soczówka (2000)		Kaczurak-Kozak (2011)	<b>Total: 3,</b> including T: 2 E: --- T/E: 1
	Entities from the heating sector			Łakomiak (2010)	<b>Total: 1,</b> including T: --- E: --- T/E: 1
	Entities from the real estate sector			Chrostowska (2023)	<b>Total: 1,</b> including T: --- E: --- T/E: 1
	Entities from the tourism sector	Czupryńska (2017)			<b>Total: 1,</b> including T: 1 E: --- T/E: ---
	Entities from the sector of higher education		Gos (2022)		<b>Total: 1,</b> including T: --- E: 1 T/E: ---
	Micro-, small, and medium-sized enterprises	Kaczmarczyk (2015), Kaczmarczyk (2021), Spoz (2015)		Stępień (2014)	<b>Total: 4,</b> including T: 3 E: --- T/E: 1
	Integrated reporting	Szczepańska (2015)			<b>Total: 1,</b> including T: 1 E: --- T/E: ---
Accounting policy		Kasperowicz (2011), Kondraszuk (2011), Krzywda (2006), Spoz (2015), Szmerekiet (2004), Świetla (2011)		Kaczurak-Kozak (2011)	<b>Total: 7,</b> including T: 6 E: --- T/E: 1

Cont. table 4.

Risk of losing the entity's ability to perform operations and its financial reporting consequences	Czupryńska (2017), Głębocka (2016a), Kumor (2016), Nowak (2010), Walińska & Jędrzejewski (2009), Zuchewicz (2009), Zyznarska-Dworczak (2010)		Chrostowska (2023), Piróg (2016), Szczepankiewicz (2013a), Szczepankiewicz (2013b)	<b>Total: 11,</b> including: T: 7 E: --- T/E: 4
Financial statements' audit	Kaczmarczyk (2011), Kumor (2016), Rówińska (2016), Zyznarska-Dworczak (2010)		Chrostowska (2023), Szczepankiewicz (2013a), Szczepankiewicz (2013b), Piróg (2016)	<b>Total: 8,</b> including: T: 4 E: --- T/E: 4
Earnings management	Artienwicz (2008), Garstecki (2012), Kaczmarczyk (2011), Kociołek (2019), Michałak (2004)			<b>Total: 5,</b> including: T: 5 E: --- T/E: ---
Accounting as a system	Kaczmarczyk (2015), Rówińska (2016), Rówińska & Zadora (2012), Spoz (2015), Świetla (2011), Wrona (2006)			<b>Total: 6,</b> including: T: 6 E: --- T/E: ---
Role of legal accounting standards	Nowak (2014), Sikorska (2005), Walińska (2002)		Piechocka-Kałużna (2018)	<b>Total: 4,</b> including: T: 3 E: --- T/E: 1
"Revenue-expense" and "balance-sheet" approaches	Bareja (2018), Głębocka (2016b), Jezierska (2008), Matuszak (2013), Rówińska (2016), Sawicka (2009)		Gos & Hońko (2016), Kumor & Poniatowska (2018)	<b>Total: 8,</b> including: T: 6 E: --- T/E: 2
Other	Czupryńska (2017), Grzegorek (2005), Gut (2011), Kondraszuk (2011), Nierzwicka (2001), Szczepańska (2015), Szmerekiet (2004)	Klimczak & Michałak (2014)	Stępień (2014)	<b>Total: 9,</b> including: T: 7 E: 1 T/E: 1

Source: own study.

As shown in Table 4, in the context of the fundamental accounting principles, the authors highlight the issue of defining both the concept of "(fundamental) accounting principles" along with certain principles, and the use of various terminology to define them. The discussion is conducted primarily about the true and fair view principle (as has already been indicated) but also, to some extent, to the prudence principle, which, for example, is also called the principle of prudent valuation or mercantile prudence (Wrona, 2006). Moreover, K. Bareja (2018) points out that introducing a new wording of this principle into IFRS in 2018 resulted in some definitional confusion. In her opinion, the term "prudence principle" should only be used with

the traditional understanding of this principle, and it is hard to call this new definition a principle, because caution is more a personal characteristic.

Polish researchers also present their own classification and hierarchy of fundamental accounting principles or those resulting from applicable accounting regulations or the literature they have studied. The links between particular accounting principles are also analyzed. For example, K. Świetla (2011) refers to a certain competitiveness that occurs between the prudence principle and the matching principle when an entity selects valuation methods as part of its accounting policy, and Z. Wierzbńska (2012) points to the conflict between the prudence principle and the accrual basis. It should also be noted that the lack of unanimity in the Polish authors' catalog of fundamental accounting principles that E. Jezierska has already noticed in 2008 is still visible. The reasons for this state of affairs could be the constantly continued evolution in application and the role of particular accounting principles.

The evolution of accounting principles mentioned above is also a part of the Polish scientific community's debate. For example, N. Artienwicz (2008), K. Kosmala (2005), M. Nierzwicka (2010), M. Sikorska (2005), and A. Spoz (2015) present the sources and development of the true and fair view concept in both Polish and European accounting regulations. They also analyze the current multidimensionality of this concept. K. Bareja (2018), M. Głębocka (2016b), A. Kaczmarczyk (2021), E. Łazarowicz (2015), and T. Kociołek (2019) discuss the directions of changes in applying the prudence principle and its contemporary and future role in accounting and financial reporting. They highlight that the traditionally understood prudence principle (i.e., indicating not to overstate the value of assets and revenues and not to understate the value of liabilities and costs) is marginalized, and IFRS has given it a new wording referring to caution while making estimates in conditions of uncertainty. On the other hand, they emphasize that the valuation of assets at values lower than their historical cost remains in these standards. It can also be noted that Polish researchers hold opposing views on the implications of evolution in the prudence principle application. For example, E. Łazarowicz (2015) states that limiting the application of this principle is right since financial statements prepared with the use of this principle do not provide useful information to its users, and the standards setters should give freedom to economic entities as to the degree of the use of the classically understood prudence principle. However, M. Rówińska and K. Zadora (2012), although indirectly because referring to the effects of the increased importance of fair value measurement, which is contrary to the prudence principle, indicate that this state of affairs constitutes the destruction of the methodological foundation of accounting. Therefore, there should be an entire agreement with the statement of T. Kociołek (2019) that the prudence principle is one of the most controversial and debatable fundamental accounting principles.

W. Gos and S. Hońko (2016), in turn, focus on the evolution and current meaning of the matching principle. They point out that although this principle is not explicitly mentioned in IFRS, it functions in accounting practice, and this is evidenced by (among others) the significant amounts of accrued expenses and deferred revenues in the companies' financial statements they investigated.

E. Jezierska (2008), M. Remlein (2010), and Z. Wierzbńska (2012) consider the impact of general changes in accounting on the overall accounting principles. They indicate, among others, that the role of the principle of going concern, accrual basis, and substance over form has increased. In contrast, the role of the prudence principle, matching principle, realization principle, and principle of historical cost has decreased. They also state that the true and fair view principle is still important. However, it has a slightly different dimension due to the increasing use of estimated values in accounting, which may cause difficulties in maintaining data reliability. The main reasons for this state of affairs are – apart from the increase in the use of estimated values – focusing on the investors' informative needs who expect information about the future and reorientating the purpose of financial reporting from the revenue-expense approach to the balance-sheet approach.

The scientific output of Polish authors on the fundamental accounting principle also includes publications on accounting principles' functioning in other countries and in international comparisons. For example, J. Koczar (2017) describes the fundamental accounting principles applicable in the Russian accounting system after the political transformation, A. Szmerekieta (2004) presents the accounting principles applicable in Germany and their hierarchy. A. Kaczmarczyk (2021), J. Krasodomska (2010), T. Kociołek (2019) identify disparities in the hierarchy of accounting principles between countries with a continental accounting system and those with an Anglo-Saxon accounting system. They point out that the prudence principle is most significant in the former, whereas the true and fair view principle is crucial in the latter.

Another identified thematic area is broadly understood financial reporting. Within this topic, almost one-third of the articles analyze the fundamental accounting principles concerning the qualitative characteristics of financial statements, including the relationships between particular principles and features and the latter's impact on the former.

The critical thematic area was also the issue of the objective of general-purpose financial reporting and the information expectations of financial statement users, the inclusion of which is one of the factors determining the accounting principles evolution.

Further, valuation, including the controversial fair value valuation, is a hot topic among Polish scientists. Ten theoretical papers address broad valuation concerns, and four theoretical articles address valuation using fair value. These publications show a discrepancy in the opinions of Polish authors on the compliance of fair value with certain fundamental accounting principles.

Within the financial reporting theme, Polish authors also analyze and describe the fundamental accounting principles with regard to the recognition, valuation, and presentation of specific reporting items (including accruals and deferrals, revenues, financial result, non-current assets held for sale, goodwill), the effects of specific transactions (including leasing, long-term contracts and transactions between affiliates) and the impairment of assets, which is a manifestation of the prudence principle application. Polish scientific achievements related to the fundamental accounting principles also include publications on accounting and financial reporting of specific economic entities, including entities providing long-term services, entities from the sector of public, heating, real estate, tourism, higher education, and micro-, small, and medium-sized enterprises. One of the Polish authors, M. Szczepańska (2015), discusses the importance of the materiality principle from the point of view of integrated reporting in socially responsible companies.

Accounting policy is another important topic covered in seven articles, six of which are entirely theoretical and one of which is theoretical-empirical. According to A. Spoz (2015), selecting rules from among the alternatives permitted by balance law is one of the main areas of risk associated with the true and fair view principle application because it is connected with subjectivity and requires appropriate professionalism. A. Krzywda (2006) and A. Kasperowicz discuss changes in accounting policy regarding adherence to the principle of consistency, ensuring financial statement information's comparability. T. Kondraszuk (2011) proposes a comprehensive approach to creating an accounting policy that can (among the others) contribute to ensuring the entity's ability to perform operations.

Another central issue area frequently covered by Polish authors is the problem of an entity's ability to perform operations. This problem is discussed in 11 publications, 7 of which are theoretical and 4 are theoretical-empirical. In this respect, Polish authors mainly detect and describe events and conditions indicating the risk of losing the entity's ability to perform operations and present the rules of their presentation in financial statements. E. Walińska and S. Jędrzejewski (2009) state that accounting principles are, by definition, inappropriate for entities that have lost the ability to continue their operation activity. They indicate that in such entities, the prudence and matching principles lose meaning and should be replaced by true and fair view concept and substance over form principle. According to E. Chrostowska (2023), A. Piróg (2016), E.I. Szczepankiewicz (2013a), and B. Zyznarska-Dworczak (2010), in determining the validity of adopting the going concern assumption the statutory auditor plays a significant role.

The statutory auditor's role is another crucial thematic area in which Polish authors analyze the fundamental accounting principles. This topic is discussed in 8 articles, including 4 theoretical and 4 theoretical-empirical. M. Rówińska (2016) points out that the goal of a statutory auditor's audit of financial statements is to check that they were created under the true and fair view principle. A. Kaczmarczyk (2011), by contrast, states that a statutory auditor is not responsible for the detection and prevention of broadly understood earnings management



practices that are contrary to the true and fair view principles because this responsibility rests with the entity's director.

The aforementioned broadly understood earnings management is also under Polish authors' discussion in the context of the fundamental accounting principles – to this issue refer 5 theoretical articles. D. Garstecki (2012) contends that ambiguity of the true and fair view principle, resulting from the lack of its explicit definition and some arbitrariness in its interpretation, fosters aggressive accounting. T. Kociołek (2019) and M. Michalak (2004) point out that, on the one hand, maintaining the prudence principle mitigates earnings management aimed at showing overly optimistic performance of an entity in its financial statement. On the other hand - as they indicate - this principle could be used as an instrument of “earnings smoothing” and showing an overly negative entity's financial performance.

In 6 theoretical articles, Polish authors, while analyzing fundamental accounting principles, also discuss the concept of accounting as a system with its specific features, goals, and canons developed over the years. According to M. Rówińska (2016) and M. Rówińska and Zadora (2012), maintaining these canons, consisting mainly of valuation based on historical cost and using the “revenue-expense” approach when preparing financial statements, has to ensure compliance with the superior true and fair view principle.

Legal accounting standards also play an essential role in ensuring compliance of the information presented in financial statements with the fundamental accounting principles. 4 articles refer to this issue, including 3 of a strictly theoretical nature and 1 of a theoretical and empirical nature.

In the Polish scientific output, fundamental accounting principles are also discussed in the context of the two existing approaches to financial reporting that are at issue, i.e., the already mentioned “revenue-expense” approach and the “balance-sheet” approach. This problem is discussed in 8 articles, including 6 theoretical and 2 theoretical-empirical. While Polish authors unanimously indicate that the matching principle is crucial in the “revenue-expense” approach, there are some contradictions in their views about the prudence principle. E. Jezierska (2008) and Ł. Matuszak (2013) state that the prudence principle is also typical for the “revenue-expense” approach. On the contrary, K. Bareja (2018) indicates that according to this approach, financial result should only reflect realized revenues and costs and, therefore, should not include those resulting from maintaining the prudence principle. That is why this author locates this principle on the border of these two accounting approaches.

Table 4 also highlights the thematic area named “Other”, within which Polish authors discuss fundamental accounting principles regarding (among the others) the tax law (Gut (2011), Nierzwicka (2001), Stępień (2004)), corporate social responsibility (Szczepańska (2015)), company management (Kondraszuk (2011)), the value relevance of earnings (Klimczak, Michalak (2004)), education in accounting (Grzegorek (2005)), and economic theories and management theories (Czupryńska (2017), Szmerekieta (2004)).

## 5. Discussion and conclusions

The content analysis of the collection of Polish authors' publications on fundamental accounting principles carried out in point 4 of this article allowed to answer the research questions posed in the introduction and thus fulfill the goal of this article.

Answering the first posed research question (*what fundamental accounting principles have received the most attention in the research done so far by Polish authors?*), it should be stated that Polish research considerations focus primarily on the overarching concept of true and fair view and also on the principles of going concern and prudence. Slightly less attention is paid to such principles as accrual basis, matching, materiality, consistency, and substance over form. The least attention received the principles of periodicity, non-compensation, cash basis, realization, historical cost, economic entity, individual valuation, and objectivity.

Concerning the second posed research question (*how do Polish authors define and hierarchize fundamental accounting principles?*) it should be pointed out that:

- Polish authors perceive and discuss the terminological inaccuracy in defining the concept of “fundamental accounting principles” and the principles of true and fair view and prudence, which results from the following premises:
  - there is no single catalog of the fundamental accounting principles, and this is due to their constantly continued evolution, simultaneous application of several different regulations in one country, and still existing differences between different countries;
  - the true and fair view principle, which originates from British commercial law, is differently translated into Polish and could be understood in both a narrow and broad sense;
  - the new wording of the prudence principle introduced by the International Accounting Standard Board in 2018 argues with the traditional understanding of this principle;
- there is no consensus in the Polish scientific community on the hierarchization and classification of the fundamental accounting principles – one presents their own, the other cites other authors, and the other refers to the applicable legal acts and standards on accounting. This could also be due to the ongoing evolution of fundamental accounting principles, the simultaneous application of numerous separate legislation in one country, and the disparities between countries.

In response to the third research question (*concerning which areas of accounting and financial reporting do Polish authors raise the issue of fundamental accounting principles?*), it should be noted that Polish authors analyze the fundamental accounting principles primarily in the context of the purpose of the financial reporting (including within the “revenue-expense” and “balance-sheet” approaches), qualitative characteristics of financial statements, information expectation of the financial statements users, and issues connected with the

valuation, including fair value measurement, in regard to which Polish authors have different opinions on its compliance with certain fundamental accounting principles. Financial audit and broadly understood earnings management are two other crucial aspects of accounting and financial reporting discussed in the context of fundamental accounting principles. The problem of an entity's ability to perform operations was also a vital point of reference.

Addressing the fourth research question (*what directions of evolution of the importance and rank of individual fundamental accounting principles have Polish authors noticed?*), it should be emphasized that:

- the true and fair view principle still remains a leading concept in accounting, even though in practice – as Polish researchers indicate – there may be difficulties in maintaining the reliability of financial data in the event of a significant increase in estimated values;
- the going concern, substance over form, and accrual basis principles got significance;
- the role of the principles of prudence, matching, realization, and historical cost decreased;
- the importance and rank of remaining fundamental accounting principles remain generally unchanged.

Polish authors point out that the main reasons for the above state of affairs are the orientation of financial reporting towards the information needs of investors, the increased importance of fair value, and the “balance-sheet” approach. Their assessment of the current direction of the importance of particular accounting principles varies.

The results of the systematic literature review conducted in this article show that the scientific achievements of the Polish authors on the fundamental accounting principles are extensive – the authors broadly discuss these principles, pointing to their definition, hierarchy, and evolution, as well as the visible manifestations of their application in financial statements. Theoretical studies dominate and are supported by empirical research only in a few cases. The significant complexity of this issue is also noticeable – Polish authors unanimously agree on some issues while expressing different views on others. The presence of this topic in many different areas of accounting and financial reporting is also evident.

This research has several limitations. First, due to the eligibility criteria used, the amount of literature position included in the examined collection of articles was limited. Second, this study has not considered non-serial publications and dissertations and only concentrated on three electronic databases chosen by the author, without considering some of the largest databases, such as Google Scholar. Additionally, this study is limited by the author's subjectivity in the articles' qualification.

Based on these limitations, it could be suggested that future research could analyze articles available in larger electronic databases or include non-serial publications and dissertations. The analysis could also be conducted not only on Polish authors' achievements but also on some broader scientific community or even on international comparisons.

Other directions of future research on the fundamental accounting principles arise from this article's findings – a conducted structured literature review showed that there is a general lack of supporting theoretical considerations with empirical research. Thus, future studies could analyze the application of the fundamental accounting principles with the use of – depending on the needs and specifications of the examined issue – qualitative or quantitative methods. Further discussions could also take a closer look at those principles whose rank and importance have changed (i.e., increased or decreased) in recent years but were not at the top in the popularity ranking among Polish researchers - i.e., the principles of accrual basis, substance over form, matching, and realization.

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## RISK MANAGEMENT STANDARDISATION IN POLISH CONSTRUCTION ENTERPRISES UNDER UNCERTAINTY

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**Purpose:** The paper aims to outline the issues related to the standardisation of risk management in construction enterprises operating in the conditions of uncertainty. In particular, it discusses possible applications of international risk management standards in the operations of major Polish contractors as participants of investment and construction processes. This is particularly important now, when contractors have to operate in the conditions of volatile and uncertain surroundings.

**Design/methodology/approach:** The paper uses the method of synthesis, as well as deduction and the basics of induction. The authors draw on their own expertise and experience gained from long-term research into risks faced by organisations from the construction industry in their operations. The publication uses a case study analysis; for that an analysis of source materials available on the Internet was carried out. All the deliberations included in the paper are based on a review of scientific literature.

**Findings:** The discussions here focus on the applicability and the utilitarian dimension of the knowledge contained in the paper. They concern major organisations which render construction and assembly services in Poland. In the context of the research one of the biggest listed construction companies in Poland, included in the stock-exchange index of WIG-Construction, is analysed. For the needs of the paper the organisation is anonymised. Some conclusions apply to all the remaining 35 companies from the WIG-Construction index.

**Research limitations/implications:** The paper presents only the selected and most relevant issues related to the standardisation of risk management in the operations of construction enterprises. The conclusions drawn from the findings apply to the construction risk, which is seen in the science as a separate research category. They also refer to the problem of uncertainty. The empirical illustration is provided by one construction enterprise only; in the scientific research a case study analysis has both its advantages and its drawbacks.

**Practical implications:** The paper contains a proposal that standard risk management solutions should be implemented by construction contractors, which have to deal with uncertainty and risks in their operations. The implicational dimension of the paper is determined by the discussed issues.

**Originality/value:** The deliberations contained in the paper may be seen as casting light on the problems of risk management standardisation in the operations of construction companies. The paper constitutes an attempt to transfer the frameworks – offered by the subdiscipline that is referred to in the scientific literature as Enterprise Risk Management (ERM) – to construction

organisations i.e. contractors. The deliberations contained in the paper may encourage broader empirical studies in this field to be conducted in the future.

**Keywords:** Construction risk, risk management standards, strategic management, construction enterprises, uncertainty.

**Category of the paper:** Conceptual paper, case study.

## 1. Introduction

Today's organisations have a lot of challenges to meet when it comes to risk management. Fundamentally, this concerns all organisations, without any exceptions, and in this case these are construction enterprises as key participants of investment and construction processes. The problem is particularly important now when construction contractors have to operate in an uncertain environment. This uncertainty is largely connected with the events that are referred to in the scientific literature as black swans (Kotnis, 2014; Taleb, 2007). The black swans determine the conditions in which construction companies carry out their business. In this context, we may point out, without much hesitation, to the COVID-19 pandemic (Myrczek et al., 2021; Curran, 2022; Wolniak, 2022), which have had an unprecedented negative impact on a number of sectors of an economy, including the construction industry. The general uncertainty in the business environment is also caused by an armed conflict in Ukraine (United Nations, 2022) that is going on right now. These are currently two key issues falling under the category of uncertainty. We should also not ignore here the long-term consequences of the global financial crisis of 2008, which has hit the construction industries worldwide. In addition, we should keep in mind the factors which may cause the construction risk to occur – such as inflation – although these are usually analysed on a smaller scale and remain beyond a contractor's control.

Whichever specific factor triggers a global risk in the construction industry, however, today's construction managers – when making decisions – need to take into account uncertainty. Therefore, people who carry out management over construction companies look at their organisations now from a slightly different angle than they used to. This also stimulates scientists to continue and explore the knowledge which is referred to in the scientific literature as Construction Risk Management – CRM (Palmer et al., 1993; Flanagan, Norman, 1993; Edwards, 1995; Hatem, 1998; Boothroyd, Emmett, 1996; Godfrey, Halcrow, 1996; Bunni, 2003; Sawczuk, 2004; Weatherhead et al., 2005; Smith et al., 2006; Loosemore et al., 2006; Saporita, 2006; Burtonshaw-Gunn, 2009); at the same time, researchers may be encouraged to seek answers to the questions about new ways of dealing with the construction risk and the measures which may be undertaken to this end. Therefore, a proposal may be put forward here that international risk management standards should be implemented by such organisations.

To put it simply, these standards are formalised procedures and specific methodology in the area of risk management, which should be used in construction enterprises. These issues are the basic subject of the discussions in the paper, which aims, first of all, to find out whether standard solutions may be implemented in business practice of major Polish construction companies.

Therefore, the key objective of the paper is to present the issues related to the standardization of risk management in the largest construction enterprises which operate in the conditions of uncertainty. It should be emphasized that the paper exposes the utilitarian dimension and the applicability of such knowledge. It constitutes, in a way, an attempt to transfer the risk management frameworks offered by Enterprise Risk Management – ERM (Jędralska, 1992; Merna, Al-Thani, 2001; Lam, 2003; Krzakiewicz, 2005; Pickett, 2006; Dallas, 2006; Damodaran, 2009; Szczepankiewicz, 2010; Kasiewicz, 2011; Chapman, 2011; Gorzeń-Mitka, Korombel, 2011; Urbanowska-Sojkin, 2012; Buła, 2015; Raczkowski, Tworek, 2017; Bożek 2018; Sorin, Anca, 2020; Ricardianto et al., 2023) to the operations of construction companies. The paper contains a review of risk management concepts and discusses the key issues in this area.

This publication is a result of the research into risk in the construction industry, carried out by its authors (Tworek, Myrczek, 2015; 2016; 2021; Kosmański, Myrczek, 2019; Myrczek et al., 2020; 2021; Myrczek, Tworek 2022). The paper provides a synthesis of a section of the knowledge in this field, combined with an in-depth review of scientific literature.

## **2. Uncertainty and (construction) risk – the theoretical approach**

The scientific literature offers a variety of approaches to the definition of both categories – uncertainty and risk. These two terms are often seen as synonymous, which is not so mistaken when looking at them in terms of organisational practice. However, in the world of science it should be noted that these are two separate research categories. In the scientific area, these notions were ultimately defined in 1921 by F.H. Knight, who saw risk as a measurable category and uncertainty as a non-measurable one (Knight, 1921). In a way, this was a turning point in the history of research into risk and the theory of uncertainty. What needs to be clearly stated here, however, is the fact that a significant number of scientists, such as mathematicians, had conducted their studies in this area even before that, as indicated in the scientific literature (Bernstein, 1997; Kaczmarek, 2008; Raczkowski, Tworek, 2017). It would be impossible to list here all the authors referred to in the scientific literature as the ones who undertook some research into risk and uncertainty in organisations. In particular, this statement applies to representatives of management and quality sciences. In other words, the more types of organisations were classified, the more groups of authors who dealt with the theory of risk and uncertainty in organisations may be found (Koźmiński, 2005; Jędralska, 2010; Jędralska,

Czech, 2011; Bochenek, 2012; Korombel et al. 2016; Raczkowski, Tworek, 2017). One should also not ignore the universal division into private and public organisations and, consequently, the division into commercial risks and public risks (Young, Fone, 2001; Fone, Young, 2007; Drennan, McConnell, 2007; Hood, Miller, 2009; Klimczak, 2009; Kumpiałowska, 2015; Fleming et al., 2016; Kosieradzka, Zawila-Niedźwiecki, 2016; Sienkiewicz-Małyjurek, 2018; Zawila-Niedźwiecki, 2018; Osborne et al., 2019); we should also keep in mind third-sector organisations (Herman et al., 2004; Chen, Bozeman, 2012; Domański, 2014; Tworek, Kozubek, 2022). Whatever types of organisations, classified in terms of ownership, from the scientific point of view it is important to remember about the key research trends, i.e. the ones which provide the definitions of risk, as compared to the notion of uncertainty. This is illustrated in Table 1.

**Table 1.**  
*Different trends in defining risk, as compared to uncertainty*

Type of trend/approach	Observations, conclusions and generalisations
Philosophical and classical basis for the definition of risk	<ol style="list-style-type: none"> <li>1. Risk is a difficult, frequently impossible to predict, potential changeability of outcome (effects) of an event.</li> <li>2. Risk is connected with: <ul style="list-style-type: none"> <li>– operating in unrecognised conditions,</li> <li>– doubts concerning the area of operation,</li> <li>– signals concerning the nature of so-called random events.</li> </ul> </li> <li>3. Risk is objective in its character and that is why it is necessary to differentiate „risk” from „risk realisation” and „management in the conditions of risk”.</li> <li>4. When defining risk it’s advisable to connect an objective element, i.e. risk itself, with a subjective element, such as a state of mind, i.e. uncertainty (risk is an objective correlate of subjective uncertainty).</li> </ol>
Neoclassical framework for an analysis of risk attributes	<ol style="list-style-type: none"> <li>5. Risk connected with business operations requires a point of reference, such as the category of profit, the value of which in the conditions of uncertainty is a variable.</li> <li>6. Risk propensity is determined by the value of an expected profit.</li> <li>7. Risk is not the same as uncertainty. Measurable uncertainty is risk.</li> </ol>
Characteristics of risk, according to the defensive trend in risk definition	<ol style="list-style-type: none"> <li>8. Risk is a negative phenomenon: a threat of a negative deviation from an aim, a potential incorrect decision to be made, a threat that an unfavourable result may be obtained.</li> <li>9. Uncertainty is a subjective category, while risk is objective.</li> <li>10. This approach is the basis for the theory of insurance, which deals with the notions of: a random event, an act of god, a fortuitous event, danger and hazard: physical, moral and spiritual.</li> <li>11. In the theory of insurance risk has many interpretations, sometimes totally different ones: <ul style="list-style-type: none"> <li>– risk as a possibility (chance, likelihood) of a loss,</li> <li>– risk as the probability of a result which differs from the expected one,</li> <li>– risk as the subject of insurance,</li> <li>– risk as uncertainty (a threat).</li> </ul> </li> </ol>

Cont. table 1.

<p>Approach to identification of risk characteristics, according to the offensive trend</p>	<p>12. Risk is inherently related to activities carried out [by an organisation] and it is a potential source of losses or profits. „Risk” has a negative meaning in the economic sense, and its positive equivalent is „opportunity”.</p> <p>13. Uncertainty is a static phenomenon, while risk is a dynamic one, closely linked to an activity.</p> <p>14. The phenomenon of uncertainty, once recognized, turns into a risk.</p> <p>When defining risk one may differentiate between objective and subjective elements.</p> <p>Objective elements include:</p> <ul style="list-style-type: none"> <li>– an undertaking or interests exposed to risk,</li> <li>– events which induce threats, the possibility of their occurrence and the time when they occur,</li> <li>– size of losses, which may be caused by these events.</li> </ul> <p>Subjective elements of risk include:</p> <ul style="list-style-type: none"> <li>– awareness [in an organisation] of threats connected with undertaken [project] or interests,</li> <li>– uncertainty – whether there is any risk in a given case, and if yes, what losses the risk may lead to,</li> <li>– a decision to take on responsibility for events which may occur.</li> </ul> <p>15. Risk is a function of uncertainty which always accompanies risk.</p> <p>16. Risk is a dynamic category, closely connected with act or omission.</p> <p>17. In the context of act [by an organisation] we may talk about the risk which:</p> <ul style="list-style-type: none"> <li>– has to be taken,</li> <li>– may be taken,</li> <li>– should not be taken.</li> </ul>
<p>Risk definition trend within the decision-making theory</p>	<p>18. Risk accompanies decision-making problems but only when there is no certainty as to the effects of a decision made (i.e. they are not determined). In these decisions risk may occur independently (in probabilistic situations) or in combination with uncertainty (in strategic situations).</p> <p>19. Decision-making in the conditions of uncertainty and risk is based on the game theory, in which – contrary to the theory of probability – there is a possibility to choose one of many action strategies available.</p> <p>20. An analysis of decision-making tasks must be conducted, together with an analysis of the environment in which these decisions are made: uncertainty, dynamics and complexity.</p>

Source: Karmańska, 2008, pp. 59-60.

When looking at Table 1 we can see that these two notions may be defined in various contexts. Undoubtedly, this is not an exhaustive list of definitions which we can come across in the scientific literature (Bernstein, 1997; Smith, 2003; Kaczmarek, 2008; Bochenek, 2012). In general, it may be assumed that risk is a much narrower phenomenon than uncertainty (Kaczmarek, 2008; Dydkowski et al. 2022). Contrary to uncertainty, risk, as a category, may be defined in the scientific field by means of probability distribution (Knight, 1921; Keynes, 1921; Arrow, 1971; Hull, 2005; Liu, Meyer, 2021), despite the fact that both the notions concern the future, which is inherently uncertain (Drucker, 1964; Collins, 1992; Jędralska, 1992; Courtney, 1994; Smith, 2003; Chapman, Ward, 2002; Krzakiewicz, 2005; Kaczmarek, 2008; Cleden, 2009; Jędralska, Czech, 2011; Kotnis, 2014; Głodziński, 2014; McGranaghan, Otto, 2022; Alós-Ferrer, Garagnani, 2022). It should be noted that the scholarly literature distinguishes one more state i.e. certainty (Wideman, 1992; Young, Tippins, 2001; Drennan, McConnell, 2007; Damodaran, 2009; Urbanowska-Sojkin, 2012; Power, 2016; Raczkowski, Tworek, 2017). No matter how the categories are defined, which research trend the theory of risk and uncertainty is set in or what divisions of organisations are taken into account in

practical terms, every organisation has its own (and sometimes) unique risk profile. This is also true about organisations operating in the field of construction, such as construction enterprises.

In general, as knowledge develops many authors in their publications have attempted to come up with new definitions of risk and uncertainty. This also concerns researchers from the subdiscipline of CRM (Flanagan, Norman, 1993; Palmer et al., 1993; Edwards, 1995; Hatem, 1998; Godfrey, Halcrow, 1996; Boothroyd, Emmett, 1996; Bunni, 2003; Sawczuk, 2004; Weatherhead et al., 2005; Loosemore et al., 2006; Smith et al., 2006; Saporita, 2006; Burtonshaw-Gunn, 2009; Tworek, Myrczek, 2016; 2021; Kosmalski, Myrczek, 2019). In particular, in the construction industry we deal with the construction risk as a separate scientific and research category; the understanding of risk in the construction industry results, first of all, from the specific nature of construction and assembly production. The scientific literature emphasises the specific features of such production, namely: first of all, immovability or permanent connection to the ground; secondly, an individual character of specific products and their high complexity; thirdly; a long production cycle; fourthly; capital intensity of the product and its longevity; fifthly; aesthetic values of products, which have a significant impact on the environment in which human beings live (Gawron, 1991). In addition, two key categories of risks in the construction industry include, first of all, risks related to nature, including weather conditions and geological conditions, and secondly, risks related to activities, such as the social risk, the political risk, the economic risk, the financial risk, the legal risk, the health risk, the technical risk, the cultural risk and the management risk (Edwards, Bowen, 1998). Here we may refer to the black swan theory, already mentioned in the introduction (Taleb, 2007) and, in particular, the COVID-19 pandemic (Myrczek et al., 2021; Chudziński et al., 2022; Myrczek, Tworek 2022), which occurred suddenly and unexpectedly in the present economic surroundings of organisations, changing the rules of a social and business life and, consequently, destroying the formerly followed standards and the image of the reality (Taleb, 2007). In the construction industry, the negative consequences of the pandemic overlapped in time with the consequences of the armed conflict in Ukraine (Curran, 2022; United Nations 2022); on one hand – this has had its impact on the operations of contractors and, on the other hand, a new category of risk, i.e. an armed conflict, emerged and has had its impact on the construction industry. Therefore, these new subcategories of a construction contractor's risk, which have hardly been researched so far, if at all, should be added to the ones addressed in the scientific literature. One should also consider the universal division into internal and external risks as well as exogenous and endogenous factors causing risks for construction contractors. Moreover, we should remember about the four main types of construction risks, i.e. the risks of time, price, quality and safety on a construction site (Flanagan, Norman, 1993). In general, the scientific literature indicates that construction risks may be divided into the ones which can – to some extent – be controlled by a contractor and the ones which are beyond their control; this division also refers to the factors which cause construction risks (Flanagan, Norman, 1993; Godfrey, Halcrow, 1996; Boothroyd, Emmett, 1996; Bunni, 2003; Loosemore et al., 2006;



Dallas, 2006; Smith et al., 2006; Burtonshaw-Gunn, 2009; Kosmalski, Myrczek, 2019). All this may lead to the statement that a big challenge for contractors now is posed by management carried out in the conditions of uncertainty i.e. in a situation when organisations are not able to fully identify and then estimate risks, in particular the ones coming from the external environment. As a consequence, there is a proposal here – in order to make risk management more effective in such organisations – that the existing international risk management standards, e.g. the ones offered by ERM (Merna, Al-Thani, 2001; Lam, 2003; Raz, Hillson, 2005; Pickett, 2006; Szczepankiewicz, 2010; Kasiewicz, 2011; Bożek, Tworek, 2011; Chapman, 2011; Gorzeń-Mitka, Korombel, 2011; Buła, 2015; Dubiel, 2016; Bożek 2018; Sorin, Anca, 2020; Haddad, Laghzaoui, 2020; Ricardianto et al., 2023) should be applied.

### **3. Towards standardisation of risk management in construction enterprises operating in the conditions of uncertainty – an attempt at a synthetic presentation of the issue**

The implementation of any risk management theory in practical operations of construction enterprises requires an in-depth knowledge of the specific character of risks that such organisations have to handle; an example may be the risk of force majeure, which is typical for the construction industry (Boothroyd, Emmett, 1996). No two contractors are identical, just like no two projects are exactly the same. It should be noted here that the construction industry is commonly regarded as a risky industry. This is due to the existence of factors which are characteristic for specific types of construction contracts; examples may include risk factors which occur in the specialised type of construction, such as the construction of gas pipelines (Kosmalski, Myrczek, 2019). Besides, risk-inducing factors occur with different intensity throughout different stages of an investment and construction process. In particular, at the project implementation stage, the risks coming from a contractor may be reflected by e.g. first of all, a lack of appropriate experience needed to perform the construction contract; secondly, too late start of construction work; thirdly, incorrect planning of the construction project; fourthly, major mistakes made at the performance stage; fifthly, engagement of inappropriate subcontractors and suppliers of prefabricated goods and construction equipment; sixthly, suspension of work due to an accident at a construction site; seventhly, violation of mandatory procedures and regulations required under the Building Law; eighthly, use of cheaper and worse quality construction materials (Tworek, 2010) etc. For comparison, the risks coming from an investor's side usually concern, first of all, a decision to discontinue a project during its implementation; secondly; mistakes in the project documentation (which is required from investors); thirdly, delays in payments for part of construction work done; fourthly, delays in commencement of construction work; fifthly, delays in commissioning of construction work;

sixthly, a lack of required expert surveys and approvals; seventhly, delays due to the introduction of changes to the project documentation (Tworek, 2010) etc. One should also not forget here about a wide range of risks coming from the other participants of the investment and construction process, such as a bank which finances the construction project.

Irrespective of the type of risks identified, the risk management process itself should be formalised in construction enterprises. In addition, a review of the literature on the subject may lead to an assumption that in today's organisations (not only the ones from the construction industry) risks should be managed in an integrated way (Merna, Al-Thani, 2001; Lam, 2003; Pickett, 2006; Dallas, 2006; Damodaran, 2009; Szczepankiewicz, 2010; Kasiewicz, 2011; Gorzeń-Mitka, Korombel, 2011; Buła, 2015; Bożek 2018; Haddad, Laghzaoui, 2020; Sorin, Anca, 2020; Ricardianto et al., 2023). Here it should clearly be stated that many international risk management standards are based on the concept of integrated risk management in organisations. Their review is presented in Table 2.

**Table 2.**

*Key international standards for risk management in organisations and their features*

Feature	FERMA	COSO II	AS/NZS
Definition of risk	Combination of probability of an event and its consequences. The standard draws attention to the existence of negative risks and positive risks but focuses, first of all, on the former ones.	A possibility that an event will occur and negatively affect the achievement of objectives. It talks about negative and positive aspects of risks (opportunities).	A possibility of an event which may occur and affect the operations of a company, leading to profits or losses, measured from the point of view of probability and consequences. Looks at negative and positive aspects of risk.
Definition of risk management	A process in which an organisation solves risk-related problems in a methodical way.	Performed by management, leadership or other personnel of an enterprise. This process is incorporated into strategies and activities across a company. It aims to identify potential events which may have a negative impact on the enterprise, to keep risks within specific limits and to provide reasonable assurance that the company's objectives are going to be met.	Culture, process and structures directly focused on obtaining benefits while controlling threats.
Application	A standard which may be used in all organisations, also in the public sector.	A universal standard addressed, first of all, to American listed companies.	A standard which may be used in all organisations.
How detailed	A very general description of the risk management process and its stages.	A very detailed description of stages within a risk management process.	A general description in the standard and a brief extension in the manual.
How formalised the process is	Indicating entities which participate in the process and a recommendation to create general internal regulations.	A risk management system, which is relatively strongly embedded in the structure of an organisation and the need to create extensive legislation.	Specification of entities involved in risk management and indicating formal documents supporting the risk management system.

Cont. table 2.

Setting objectives	No specific section on setting objectives. It emphasises the impact of risk management on the achievement of strategic objectives.	Setting of objectives is one stage within a risk management process. It emphasises the correlation between risk management and the achievement of strategic objectives. There are four types of objectives: strategic, operational, reporting and compliance.	Setting of objectives is incorporated into a risk management process.
Risk identification	Risk identification is seen as part of a risk analysis, in which types of risks and their estimations are described. Some hints are given in this respect. It is recommended that risk identification should be carried out in a methodical way to ensure that all actions are defined. An attachment to the standard includes a short list of risk identification techniques.	Within risk identification the standard refers to an analysis of the internal and external surroundings of a company, which may be a source of events that positively or negatively affect the implementation of a strategy (it provides a catalogue of exogenous and endogenous factors). COSO provides detailed information on risk identification techniques (supplemented with examples).	AS/NZS does not dedicate much space to risk identification. It emphasizes the need for regularity, whether a risk is controlled by an organisation or not. The standard provides guidelines on what information is needed to identify risks, the method for risk identification and the documentation which closes this stage of the process.
Risk measurement	Once risk is assessed, a reference must be made to pre-established criteria and a decision needs to be taken on how to proceed.	No separate section on measurement. Some references to risk measurement may be found in the section which deals with risk assessment and risk responses.	The guidelines section includes criteria for measurement and a concept of acceptable risk. No references to historical events in the determination of the criteria for assessment.
Reporting and communication	Reporting and (internal and external) communication precede the risk response section.	Under COSO, reporting and communication follow risk responses and audit activities.	Issues on reporting and communication are presented in part one of the standard.
Risk response	FERMA does not devote much attention to this issue. It points out that a risk response comprises risk control and risk mitigation, as well as risk avoidance, risk transfer and risk financing.	COSO distinguishes four possible risk responses: avoidance, reduction, sharing, acceptance. It provides a brief analysis of costs and benefits. A more detailed approach can be found in a section on application techniques.	AS/NZS describes separately actions connected with risks, which bring positive and negative consequences. The main part of the standard contains a brief analysis of costs and benefits of every risk response described, but more details on this topic (qualitative and quantitative analyses) are given in the section containing guidelines.

Cont. table 2.

Monitoring of the risk management process	Monitoring should provide information on risk identification and appropriate control activities.	COSO distinguishes two types of monitoring – ongoing monitoring and ad hoc monitoring. The standard provides a detailed description of the observation process, including subjective and objective scopes of reporting.	Ongoing monitoring combined with drawing of conclusions is very important in the risk management process. The section with guidelines includes a detailed description of monitoring and measuring of effectiveness of the risk management process.
Responsibility for risk management	The standard specifies the roles and responsibilities for: management, business units, a risk management unit and internal audit. In addition, it discusses a risk management policy and resources for the implementation of the process.	The standard specifies roles and scopes of responsibility for: management, directors, CRO, CFOs, internal auditors and external parties. The supplementary part contains detailed examples of job profiles for CRO, CEO, audit committee and a risk committee.	The AS/NZS standard makes a very general reference to this topic and discusses the following issues: evaluation of current practices, ensuring support from senior management, establishing responsibility, ensuring appropriate resources.
ERM limitations	Does not cover this topic.	Even the best risk management system is not bound to lead to the achievement of objectives. COSO indicates the following limitations: a management process, human error, repeated attempts to outsmart control processes, costs of risk responses.	Does not cover this topic.
Supplementary documents	References to ISO/EIC standards	Strongly connected with COSO (internal control) and the provisions of the Sarbanes-Oxley Act.	Suggested use of additional standards for specific types of risk.

Source: Kasiewicz, 2011, pp. 93-96.

Table 2 is basically a synthesis of the features demonstrated by the specific risk management standards, which are listed there. These are the key standards that have been developed through organisational practice. What matters here is the fact that many of the components of the standard solutions presented in Table 2 have their origin in the risk (and uncertainty) management theory as such. More specifically, this may apply to, on one hand, the very definition of risk and the way a risk management process runs in organisations, and on the other hand, the methodical approach to risk management; methodical aspects are a particularly important element of the modern knowledge of risk management in organisations (Merna, Al-Thani, 2001; Lam, 2003; Pickett, 2006; Dallas, 2006; Kasiewicz, 2011; Chapman, 2011; Kumpiałowska, 2015; Buła, 2015; Kozieradzka, Zawila-Niedźwiecki, 2016; Bożek 2018). Risk and uncertainty management is inextricably linked to the stages of strategic management, i.e. strategic thinking and strategic action (Jędralska, Czech, 2011).

Apart from the risk management standards listed in Table 2, special importance should be attached to ISO 31000:2009 standard (The International Organization for Standardization) Risk Management – Principles and guidelines, including supplementary documents, i.e. ISO Guide

73:2009 – Vocabulary and ISO/IEC 31010:2009 – Risk Assessment Techniques (ISO 31000; Dubiel, 2016; Haddad, Laghzaoui, 2020); in Poland an equivalent to this standard is a new version of a risk management norm of PN-ISO 31000:2018 (Bożek, 2018). In organisational practice it plays quite a significant role, when compared to the other standards listed in Table 2. The reason is, first of all, the fact that it is certified by ISO. However, one cannot exclude also other standard solutions which, similarly to ISO 31000, have their advantages and drawbacks. A clear advantage of the British standard of FERMA (The Federation of European Risk Management Associations), which was developed for public organisations (FERMA, 2004) by The Institute of Risk Management – IRM, The National Forum for Risk Management in the Public Sektor – ALARM and The Association of Insurance and Risk Managers – AIRMIC, is its simplicity. The standards of COSO II (The Committee of Sponsoring Organizations of the Treadway Commission) and AS/NZS (Standards Australia and Standards New Zealand) were developed for private organisations and are more complex (COSO, 2004; Raz, Hillson, 2005; Pickett, 2006; Haddad, Laghzaoui, 2020; Sorin, Anca, 2020). They require specific expertise. Nevertheless, a number of solutions offered by these standards are – to a varying extent – used by participants of investment and construction processes; this is, first of all, due to high universality of their applications. A separate scientific monography would be required in order to present them in more detail, since there are many more international risk management standards available worldwide.

### **3.1. One of the largest Polish construction enterprise – a case study analysis**

In Poland the largest construction enterprises are listed on the Warsaw Stock Exchange under the stock-exchange index of WIG-Construction. In compliance with the effective regulations all information is made public and is generally available on the Internet. A detailed analysis of the thirty six construction companies may lead to a conclusion that responsibility for risk management in organisations is carried by senior management. In such companies there is an obligation to have their risks identified and analysed, but different organisations have their risk management processes formalised to a different extent. For example, in their integrated report for 2020 one of the key companies managing a very big portfolio of construction investments (a group of construction companies) identified the following types of construction risks:

- „(...) broadly understood economic uncertainty caused by the COVID-19 pandemic,
- a rise in prices of construction materials, crude oil derivatives and energy,
- a rise in prices of services, a limited availability or bankruptcy of subcontractors,
- a rise in labour costs and a limited availability of skilled workers,
- delays in timely performance or insufficient work quality of subcontractors,
- delays in obtaining of required administrative decisions,
- changes to the scope of work or to technologies specified in contracts,
- unfavourable weather or land conditions” (2020 Report).

According to the report, despite having control mechanisms in place and general protection against (credit, currency and third party liability) risks in an organisation, some factors may still occur and lead to the project performance with a profit margin lower than the originally planned one (2020 Report). At the end of the day, every risk finds its reflection in a financial result generated by a construction enterprise. For the sake of comparison, in 2022 the key risk identified in the operations of the company were deteriorating conditions on the market of construction and assembly services in Poland (2022 Report). That risk was seen as a very serious one, possibly leading to some delays in transfers of funds or a reduction in funds available for the performance of infrastructure and railway construction projects, high inflation, a rise in prices of fuels and energy and an increase in costs of construction and assembly production (2022 Report).

In organisational practice the contractor under review, on one hand, issues a map of key risks for their organisation, to be presented at meetings of their management board and audit committee and, on the other hand, a map of other risks controlled and monitored by departmental directors of the group of construction companies, who also sit on supervisory boards in subsidiaries (2020 Report). When reviewing the information given on the contractor's website, we can see that in practical terms risk management is carried out slightly differently to the content of Table 2; practice often differs from theory. The experience gained by managers from the performance of construction contracts effectively limits the key non-financial risks, i.e. the ones coming mostly from engaged subcontractors (2020 Report). It should be noted that the surveyed contractor, just like all the remaining construction companies included in the stock-exchange index of WIG-Construction, operated in the conditions of uncertainty, at the time of a so-called black swan i.e. the COVID-19 pandemic. In addition, a compliance policy, which they put in place, also played its role, although in 2022 the risk in that area was identified as moderate (2022 Report).

#### **4. Conclusions**

All the deliberations included in this publication may be summarised in two ways, i.e. from the theoretical point of view and from the practical one. On the background of the theory of organisational management and risk management or, in general, organisational management in the conditions of uncertainty, we may agree with many authors in the scientific literature that uncertainty and risk are interlinked notions (Knight, 1921; Bernstein, 1997; Krzakiewicz, 2005; Kaczmarek, 2008; Karmańska, 2008; Jędralska, Czech, 2011). This refers to the content of Table 1. In particular, when applying the theory to construction enterprises operating in uncertain and risky situations, it should be stated, first of all, that there are different types of uncertainty (Jędralska, 1992) and there are different construction risks; and secondly,

the construction risk is a narrower concept than the category of uncertainty; thirdly; it is difficult to specify the state of certainty in the construction industry; fourthly, building contractors make some decisions without having complete knowledge of the future and some decisions when having such knowledge, i.e. in the state of certainty (Chapman, Ward, 2002; Hull, 2007; Alós-Ferrer, Garagnani, 2022; McGranaghan, Otto, 2022); fifthly, (in the construction industry) a lack of any knowledge of the future concerns the notion of uncertainty (Collins, 1992; Wideman, 1992; Bernstein, 1997; Koźmiński, 2005; Jędralska, 2010); sixthly, depending on the trend in the definition of risk (Table 1), risk management carried out by a contractor may be seen, on one hand, as an opportunity, and on the other hand, as a threat (Kaczmarek, 2008) – and this aspect is particularly important from the point of view of the theory of risk management in construction enterprises.

The other context of the deliberations is practical knowledge. Fundamentally, the international risk management standards outlined here have their origin in the organisational practice, which is often referred to as consulting (Table 2). Therefore, this knowledge should be considered in terms of function and functionality (Tworek, Myrczek, 2016). In particular, practical risk management in construction enterprises should be analysed in an integrated way, which means that, first of all, risk management in all areas of a construction company's operations; secondly, responsibility for risk and uncertainty in an organisation is defined and rests with internal audit and audit committees within supervisory boards (in listed construction enterprises included in the stock exchange index of WIG-Construction); thirdly, all the risk management methods are used in a complementary way; fourthly, risk management concerns an organization's surroundings, including its external environment – these are the conditions of the COVID-19 pandemic or the effects on the construction industry of the armed conflict in Ukraine; fifthly, risk management supports the general management over a construction enterprise; sixthly, risk management is ongoing and regular, and it is viewed as a process; seventhly, effective risk management reduces the global risk a construction contractor has to face" (Tworek, Myrczek, 2016). In general, this is a systemic approach to risk management in construction enterprises operating in the conditions of uncertainty, which may apply, in particular, to the thirty six largest Polish construction contractors.

Summing up, contractors operating in the conditions of uncertainty need to implement in their organisations the solutions offered by international risk management standards. In case of the Polish largest construction enterprises listed on the WSE, this refers to the standard of COSO II or a concept of implementing the standard of ISO 31000. This may help many contractors to avoid unnecessary additional consequences of risks, which complies with the construction risk mechanism described in the literature on the subject (Palmer et al., 1993; Flanagan, Norman, 1993; Edwards, 1995; Hatem, 1998; Boothroyd, Emmett, 1996; Godfrey, Halcrow, 1996; Bunni, 2003; Sawczuk, 2004; Weatherhead et. al., 2005; Smith et al., 2006; Loosemore et al., 2006; Saporita, 2006; Burtonshaw-Gunn, 2009; Tworek, Myrczek, 2016;

2021; Kosmalski, Myrczek, 2019). The implementation of the existing risk management standards in the operations of construction contractors seems to be the best solution.

However, when trying to define how widely the standard risk management solutions outlined in this publication are used by all the building contractors operating on the Polish market, a countrywide empirical study should be conducted. This, however, may be a task for the future. The present publication may inspire other researchers dealing with risk management and uncertainty in organisations to undertake such studies.

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## HOW DO INDIVIDUAL INVESTORS RATE THE SIGNIFICANCE OF THE SOCIAL ASPECTS OF CORPORATE REPUTATION? EVIDENCE FROM POLAND

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**Purpose:** The aim of the article is to examine the importance of the social aspects of company's reputation assessment for individual investors in the context of their decision-making process in the field of investing in the capital market.

**Design/methodology/approach:** Based on the concept of the multidimensional character of reputation, it was recognized how important social aspects of reputation are for individual investors in the process of making investment decisions, depending on their gender, age and investment experience. Survey research was conducted on a group of 417 individual investors operating on the Polish financial market. Research hypotheses were verified using statistical methods (Kruskal-Wallis and Dunn tests).

**Findings:** The social aspects of the reputation of enterprises are perceived by the surveyed investors as moderately important. However, the importance of the specified aspects (criteria) varies depending on age, gender and investment experience.

**Research limitations/implications:** Our research is limited to individual investors from one country only. Therefore, the obtained results cannot be generalized and treated as representative for this group of investors.

**Social implications:** The results of our research broaden and supplement the knowledge in the area of reputation in relation to individual investors, indicating that the gender, age and investment experience of investors are important when assessing the social aspects of a company's reputation.

**Originality/value:** The study is in line with previous research indicating the growing importance of reputation and its social aspects as decision-making criteria for investors. The obtained results contribute to the agency theory, confirming the attitude and expectations of individual investors towards the management boards of companies. In order to identify the importance of social aspects of reputation for individual investors, an original approach was used to define the social dimensions of corporate reputation (eight criteria were indicated that could be measurably assessed by investors).

**Keywords:** corporate reputation, social aspects of corporate reputation, individual investors.

**Category of the paper:** research paper.

## 1. Introduction

Corporate reputation is perceived as a very valuable asset of the company according to many theories developed over the last several decades, namely: strategy theory, resource-based value theory, stakeholder theory, signaling theory, institutional theory. From the point of view of strategy theory, a strong positive reputation is an excellent strategic asset because it effectively protects against attacks by competitors, constitutes a large barrier to potential competitors, and builds the credibility and trust of stakeholders (Fombrun, Shanley, 1990; Dolphin, 2004; Brønn, Brønn, 2015). According to the resource approach, reputation as a valuable, difficult or impossible to imitate, intangible resource of an enterprise can be a source of long-term competitive advantage (Barney, 1991; Hall, 1993). The stakeholder theory draws attention to the growing importance of various stakeholder groups and the possibility of their impact on the company and creating its reputation (Soleimani et al., 2014; Gao et al., 2017). According to the signaling theory, reputation is treated as a signal to stakeholders and the market that informs about the company's situation (Hetze, 2016). On the basis of institutional theory, reputation as the perception of the company by stakeholders is seen as an important determinant of the institutional development of the company (Deephhouse et al., 2016).

According to the results of research by many authors from the last two decades, companies with a strong, positive reputation achieve better economic and financial results (Roberts, Dowling, 2002; Cole, 2012; Flanagan et al., 2011; Schwaiger, Rathel, 2014; Tischer, Hildebrandt, 2014). In addition, a good reputation allows to more easily and better survive various types of crises, both economic crises (Raithel et al., 2010) and corporate crises (Shu, Wong, 2018). The benefits generated by a good reputation result from the fact that reputation becomes one of the main determinants of behavior and decisions of many stakeholder groups, including primarily customers and investors (Schwaiger, Raithel, 2014; Baumgartner et al., 2020).

The research undertaken in the article was inspired, on the one hand, by the growing interest in the area of corporate social responsibility in recent decades (Frerichs, Teichert, 2023; Lis, 2019; Latapí Agudelo et al., 2019), including investments in the capital market (McMillan et al., 2017; Adamska, Dąbrowski, 2016; Ioannou, Serafeim, 2015) as well as corporate reporting policy (Nicolò et al., 2023), and on the other, the growing share of individual investors in trading on the Warsaw Stock Exchange in recent years (GPW, 2022).

At the same time, in the course of the literature review, it was noted that there is a limited amount of research on the perception of the importance of social aspects of corporate reputation by individual investors, including a cross-section by social characteristics and investor experience. The lack of such research in countries that are not economic leaders and characterized by a middle income level has been identified as a research gap. The article tries to fill this gap, which is its basic contribution, both theoretical and empirical, to the existing



literature. We try to answer the research question: how do individual investors assess the importance of the social aspects of the company's reputation in the process of making investment decisions, taking into account the diversity of these investors in terms of gender, age and investment experience.

In the article we propose an in-depth and more comprehensive approach to examining the importance of the social dimension of reputation for investors. We describe the social dimension of reputation using eight specific determinants, which the surveyed investors are able to respond to. Importantly, these are issues that investors can check in company reports or on their corporate websites. We verify our hypotheses on the basis of the results of a survey conducted on a sample of 417 individual investors operating on the Polish capital market.

The article consists of the following sections. Section 2 presents the theoretical background and our hypotheses development. Section 3 shows the research methodology. Section 4 presents the results. Section 5 is the discussion. Section 6 covers conclusions, limitations and future research directions.

## **2. Theoretical Background and Research Hypotheses**

### **2.1. Multi-faceted Corporate Reputation**

The nature of reputation as a general category, and the company's reputation in particular, is very complex, ambiguous, amorphous (Deephouse, Carter, 2005; Lange et al., 2011; Gardberg, 2017). Therefore, it is a category that is difficult to define and measure (Chun, 2005; Walker, 2010; Clardy, 2012). Although corporate reputation has for many years been the subject of multi-faceted research and deliberations by specialists in various fields (including management, marketing, economics, finance, and sociology), it has not yet received a single, universally accepted definition (Podnar, Golob, 2017; Money et al., 2017).

The most frequently cited is the definition of reputation formulated by Fombrun and Van Riel (1997), according to which reputation is an aggregated assessment of the company's past, present and planned activities, based on the perception of various groups of stakeholders: customers, employees, suppliers and business partners, investors, administrative authorities and regulators, local communities, non-governmental organizations, media. According to this definition, reputation is a complex construct based on the perception of many different groups of stakeholders, each of which has different needs and expectations, and therefore evaluates the company and its activities from a different perspective (Fombrun et al., 2000; Martinez, Norman, 2004). For this reason, reputation management is a very difficult challenge for managers, as it requires taking into account the points of view and interests of those groups that may be contradictory (Chun, 2005; Carter, 2006).

Stakeholders, when assessing the company and various aspects of its operations, are guided by both rational criteria, based on the cognitive sphere, as well as emotional premises, based on the affective sphere. The cognitive sphere concerns the assessment of various competences of the company, while the affective sphere concerns the assessment of feelings and sympathy towards the company (Schwaiger, 2004). In the reputation measurement process, each of these dimensions can be assessed using appropriate measures. Raithel and Schwaiger (2015) proposed three indicators for each dimension (Table 1).

**Table 1.**

*Indicators of the operationalization of the cognitive and affective dimensions of reputation*

Competence items:	Likeability items:
<ul style="list-style-type: none"> <li>• [The company] is a top competitor in its market.</li> </ul>	<ul style="list-style-type: none"> <li>• [The company] is a company that I can better identify with than with other companies.</li> </ul>
<ul style="list-style-type: none"> <li>• As far as I know, [the company] is respected worldwide.</li> </ul>	<ul style="list-style-type: none"> <li>• [The company] is a company that I would miss more than other companies if it did not exist anymore.</li> </ul>
<ul style="list-style-type: none"> <li>• I believe that [the company] performs at a premium level.</li> </ul>	<ul style="list-style-type: none"> <li>• I regard [the company] as a likeable company.</li> </ul>

Source: own work based on: Raithel, Schwaiger, 2015.

A similar approach to the dimensions of reputation was presented by Lange, Lee and Dai (2011). In their reputation model, they identified two fundamental dimensions: being known for something, generalized favorability. Dimension, being known for something, relates to the cognitive realm, and deals with very specific, rational aspects of reputation that can be judged on the basis of "hard" evidence. It is about the level and scope of competence, professionalism and professionalism, which are assessed by individual groups of stakeholders. On the other hand, the dimension of generalized favorability concerns the affective sphere and refers to the "soft", emotional aspects of reputation. The company is assessed by stakeholders in terms of honesty and transparency of activities, compliance with the law and ethical standards, respecting and respecting the values of stakeholders. Due to the distinguished dimensions of reputation, the literature talks about competence reputation (cognitive dimension) and character reputation (affective dimension) (Mishina et al., 2011).

When analyzing the cognitive aspects of reputation relating to the cognitive sphere in relation to investors, it can be concluded that they relate to the company's competences in managing the company in various spheres, and the assessment of these activities is based on "hard" economic and financial data (profit rate, share price, goodwill, etc.). On the other hand, the affective aspects, relating to the emotional sphere, concern the level of feelings such as sympathy, admiration, and respect felt on the basis of the assessment of the company's actions and behavior as an employer, philanthropist, citizen, member of the local community. The level and type of these feelings is based on the perception of other than purely business activities and aspects of the company's operation, such as: social commitment, charity, honesty and transparency, compliance with legal and ethical standards, treatment of other stakeholder groups, etc.

In previous studies, the authors have focused on studying the impact of corporate social involvement on investor decisions, financial performance, share prices or the cost of capital (Cordeiro, Tewari, 2015; McMillan et al., 2017; Elmghaamez, Olarewaju, 2022). Research conducted in recent years shows that the company's reputation is becoming an increasingly important decision-making criterion for many groups of investors i.e. individual shareholders, public investors, investment funds (Helm, 2007b; Aaron et al., 2012; Blajer-Gołębiewska, 2014). Moreover, reputation determines investors' responses to corporate crises to a greater extent than "hard" financial performance (Sohn, Lariscy, 2015; Harrington, 2019).

## **2.2. Social Aspects of Reputation from the Perspective of Investors**

Investors' decisions are conditioned by both rational and emotional motives. For many years, economists and financial analysts have been conducting research on the behavior and motivations of stock market investors, as well as developing theories and decision models (De Bondt, 1998; Ryan, Buchholtz, 2001; Andersen, 2009). According to the assumptions of the first theories and models, the main decision-making criteria of investors were rational premises, based on a fundamental analysis and reliable forecasts regarding the company's planned investments (Gutter et al., 1999; Hon-Snir et al., 2012). The development of such fields as behavioral economics or behavioral finance (Camerer et al., 2004) and subsequent research have shown that investors are driven not only by rational motives, and the decision-making process is much more complex. It turned out that investors are also guided by feelings and emotions resulting from the evaluation of non-financial aspects of reputation (Lucey, Dowling, 2005; Andersen, 2009; Chadha et al., 2019; Rahman, Gan, 2020). Based on a review of research conducted in recent years, the following non-financial aspects of reputation are becoming increasingly important as investor decision-making criteria:

- corporate social commitment (Ioannou, Serafeim, 2015; Eccles, Klimenko, 2019),
- the manner and style of reporting financial and non-financial information (Elliot et al., 2017),
- transparency and method of communication (Albu, Flyverbom, 2016; Schnackenberg, Tomlinson, 2016),
- opinions of other stakeholder groups and the company's approach to other stakeholders (Galbreath, 2010; Luo et al., 2014; Schwarzmüller et al., 2017).

CSR and corporate reputation are two closely related categories and concepts (de Quevedo-Puente et al., 2007), also referred to as two sides of the same coin (Hillenbrand, Money, 2007). On the one hand, CSR is one of the aspects and determinants of reputation that is taken into account in reputation measurement concepts. In the Fortune's Most Admired Companies ranking, social responsibility is one of the nine determinants of reputation, alongside innovation, product quality, management quality, financial health, personnel management, resource utilization, long-term investments and global competitiveness (Cheng et al., 2017).

CSR is also one of the areas included in the reputation assessment using the Reputation Quotient (Fombrun et al., 2000) and the reputation index of M. Schwaiger (Schwaiger, 2004).

On the other hand, CSR is an important and increasingly important tool for building and supporting the company's reputation. This is due to the fact that the corporate social commitment has been appreciated and positively assessed for many years by almost all stakeholder groups (Pfau et al., 2008; Peloza, Shang, 2011; Jensen et al., 2018; Kim, Ferguson, 2019).

In research and analyzes, the authors prove that CSR activities carried out by a company have a positive impact on building its desired reputation (Fombrun, 2005; Khojastehpour, Johns, 2013; Aksak et al., 2016). Research conducted by Cooper and Weber (2021) in the USA showed that 1/3 of the surveyed investors prefer to invest in benefit corporations that have higher standards of transparency and are focused on achieving social goals. Referring to Polish conditions, Adamska and Dąbrowski (2016) showed in their research that investors react positively to the increase in the level of social involvement of the company, and negatively react to the decrease in this level. They formulated these conclusions on the basis of research in which they used the event study methodology, based on the assessment of the impact of including or excluding companies from the RESPECT Index (including companies declaring social responsibility; currently ESG Index) on the rate of return on capital.

The effectiveness of initiatives aimed at raising the social aspects of the company's reputation depends on the selection of actions expected by customers and efficient information about them (Walsh, Beatty 2007; Moreno, Kang, 2020). Appropriate information and CSR reporting is important for building the desired reputation (Pérez, 2015). The results of research conducted by Du et al. (2017) suggest that sustainability reports increase information transparency and allow investors to include sustainability information in stock valuation. A higher level of CSR disclosure positively affects the valuation of company shares (Mallin et al., 2014), with this effect being more visible in industries with a stronger environmental impact (De Klerk et al., 2015). Research conducted among managers of large and medium-sized enterprises in Poland responsible for CSR indicate that the highest efficiency is achieved by activities aimed at employees and customers (Zieliński, Jonek-Kowalska, 2020).

The credibility of the message is important because the ability of consumers (and other stakeholders) to accurately identify the actions taken by companies is generally low (Sen et al., 2006). Investors assess the credibility of the management board's actions not only on the basis of data published by the company, but also from other sources e.g. press releases, because companies can use the greenwashing strategy, disclosing manipulated information (Saeed, 2021), highlighting received distinctions and awards, avoiding information on penalties and fines as well as pending court cases against the companies.

From the perspective of the undertaken research subject, what is important is the shareholding structure and policy towards shareholders (including minority shareholders) who expect reliable and complete information, keeping promises and pre-emption rights. Since institutional shareholders can influence the company's strategic decisions e.g. the scale of social responsibility activities (Deakin, Hobbs, 2006; Sakawa, Watanabel, 2020), the time horizon of their investments is important. The dominance of long-term investors favors an increase in spending on social activities, while the dominance of short-term investors causes their reduction (Erhemjamts, Huang, 2019).

Minor and Morgan (2011), based on a long-term analysis of the stock prices of companies from the S&P 500 index, show that companies with higher CSR ratings are better at coping with reputational crises. Research by Aaron et al. (2012) and McMillan et al. (2017) showed positive reactions of investors to the social commitment of the company, which was reflected in the higher market valuation of the company. Ioannou and Serafeim (2015) indicate changes in investment recommendations issued by analysts for companies showing a strong commitment to CSR activities – from rather pessimistic in the early 1990s to more optimistic.

The current review of the literature allows us to put forward the first research hypothesis:

*H1.* The most important criterion for assessing the reputation of enterprises in the area of social aspects for individual investors is the involvement of enterprises in socially responsible activities.

From the perspective of the article subject it is important to characterize individual investors, taking into account their social characteristics (gender and age) and investment experience. Study conducted among 750 retail investors in the United States showed that female investors were more interested in information about the company's social activity compared to men and declared a greater future demand for this information (Nath et al., 2013). Other studies show that, in general, young people and women as investors are more sensitive to social aspects (Nel et al., 2021; Wang et al., 2020; de la Ville, 2014) and are more likely to believe that social performance and environmental firms are as important as financial performance (Eng-Tuck Cheah et al., 2011).

The research results quoted above allow to formulate three further research hypotheses:

*H2.* Women ascribe higher importance to social criteria for assessing the reputation of enterprises than men.

*H3.* Social criteria for assessing the reputation of enterprises are more relevant for young individual investors, i.e. up to 25 years.

*H4.* Social criteria for assessing the reputation of enterprises are more important for more experienced individual investors, i.e. over 10 years of activity.

### 3. Research Methodology

In order to verify the research hypotheses, a survey addressed to individual investors was conducted. For this purpose, the googledocs form was made available to investors on the public forum of the stock exchange portal StockWatch.pl. Completing the form was voluntary. The research sample, finally obtained, consisted of 417 respondents differentiated by gender, age and investment experience (Table 2), which resulted in a confidence level of 0.95, a maximum error of 5%, and a fraction of 0.5.

**Table 2.**

*The sample structure*

Characteristics of survey participants	Research		Research – Association of Individual Investors (Poland)
	Number of respondents	Share	Share
<i>Gender</i>			
Male	316	75,8%	90,2%
Female	101	24,2%	9,8%
<i>Age</i>			
less than 25 years (<25)	161	38,6%	8,0%
25-45 years (25-45)	180	43,2%	60,5%
above 45 years (45<)	76	18,2%	31,5%
<i>Investment experience</i>			
less than 1 year (<1)	176	42,2%	47,1%
1-5 years (1-5)	71	17,0%	
5-10 years (5-10)	53	12,7%	18,8%
above 10 years (10<)	117	28,1%	34,1%

Source: own work and Stowarzyszenie Inwestorów Indywidualnych (*Association of Individual Investors*), 2021.

The survey questionnaire contained 26 questions concerning information, financial and growth as well as social aspects of reputation. In the article, we discuss only the results relating to the social aspects (answers to 8 questions). Respondents evaluated individual criteria of corporate reputation with a six-point scale from 0 to 5, where 0 means completely irrelevant, and 5 very important. We used a six-point scale to eliminate neutral responses to the importance of a given criterion.

The criteria for assessing corporate reputation included in the survey form were proposed on the basis of literature studies in the field of corporate reputation assessment (Helm, 2007a; Fombrun et al., 2013; Marzouk, 2016; Cheng et al., 2017; Naveed et al., 2020), the scope of publicly available information about the situation of listed companies (including, in particular, periodic reports and corporate websites) and the research part author's many years of experience in the area of investments on the stock market and fundamental analysis of listed companies. All survey questions in the social area are shown in Table 3.

**Table 3.***List of survey questions in the social aspects area (How do you rate the significance of...?)*

Criterion
1. Shareholders' structure
2. Policy of majority shareholders towards minority shareholders
3. Credibility of the company's management
4. Court cases
5. Penalties and fines
6. Honours and awards
7. Press releases about the company and opinions on web portals
8. Company's involvement in socially responsible activities

Source: own work.

Due to the fact that the collected assessments of the significance of individual social criteria for assessing corporate reputation did not meet the assumptions of the normal distribution (Shapiro-Wilk test failed), to determine whether there are differences in the perception of the significance of these criteria among individual investors depending on gender, age or investment experience the non-parametric Kruskal-Wallis H test was used, considering a significance level at  $p < 0.05$  (any value less than 0.05 is considered as significant).

Finally, to verify results of the Kruskal-Wallis test, as well as identify significantly different groups within investors' sample, the Dunn's test/procedure of pairwise comparisons was performed (also considering a significance level at  $p < 0.05$ ). The assignment to different groups was consistent with the decreasing order of mean of ranks values (group A – the highest values, further groups B, C, ... lower and lower values).

For both tests,  $p$  values  $> 0.05$  indicated that the  $H_0$  hypothesis that samples came from the same population could not be rejected, and  $p$  values  $< 0.05$  indicated the rejection of the  $H_0$  hypothesis and the acceptance of the alternative hypothesis  $H_a$  that the samples did not come from the same population.

Statistical analysis was performed using XLSTAT.

## 4. Research Results

The results of the study are presented broken down into the general significance of individual social criteria of corporate reputation assessment for the surveyed individual investors and its differentiation in terms of gender, age and investment experience of investors. The order of presentation of the results is thematically consistent with the order of the research hypotheses formulated in the introduction.

#### 4.1 General Results

In general terms, the social criteria for evaluating the reputation of enterprises are perceived by the surveyed investors as moderately important. The average significance score for all social criteria is 3.30 on a scale from 0 to 5. The average scores for individual social criteria together with their standard deviation and detailed distribution of investor indications (in %) are presented in Table 4.

**Table 4.**  
*Importance of social reputation criteria*

Criterion	0	1	2	3	4	5	Mean	Std. deviation
1. Shareholders' structure	3%	5%	15%	35%	30%	12%	3,18	1,18
2. Policy of majority shareholders towards minority shareholders	2%	5%	10%	27%	29%	28%	3,61	1,21
3. Credibility of the company's management	0%	1%	3%	9%	23%	64%	4,44	0,88
4. Court cases	1%	5%	13%	30%	29%	21%	3,46	1,17
5. Penalties and fines	1%	5%	12%	26%	32%	24%	3,56	1,17
6. Honours and awards	10%	15%	18%	29%	18%	10%	2,61	1,44
7. Press releases about the company and opinions on web portals	4%	11%	15%	30%	23%	17%	3,08	1,36
8. Company's involvement in socially responsible activities	13%	17%	21%	21%	16%	11%	2,44	1,54

Source: own work.

Among the considered social criteria for assessing the reputation of enterprises, the "Credibility of the company's management" (4.44) is by far the most important for individual investors. In turn, the least important are "Company's involvement in socially responsible activities" (2.44) and "Honors and awards" (2.61).

Therefore, it can be concluded that the hypothesis *H1*, i.e. "the most important criterion for assessing the reputation of enterprises in the area of social aspects for individual investors, is the involvement of enterprises in socially responsible activities" was not confirmed and should be rejected. It should also be noted here that the low importance of the criterion of "Company's involvement in socially responsible activities" for Polish individual investors may result from its insufficient and too simplified understanding.

#### 4.2 Results By Gender

The analysis of the survey results according to the gender of the respondents showed quite significant differences in the assessment of the criteria by women and men (Table 5). For some criteria, the differences are minimal (e.g. "Shareholders' structure", "Court cases"). The biggest differences (over 1) concern "Company's involvement in socially responsible activities". Women rate the importance of this criterion higher.



**Table 5.***Importance of social reputation criteria – gender differences*

Criterion	Gender	0	1	2	3	4	5	Mean	Std. deviation
1. Shareholders' structure	Female	5%	4%	20%	30%	29%	13%	3.12	1.27
	Male	3%	5%	14%	36%	30%	11%	3.20	1.15
2. Policy of majority shareholders towards minority shareholders	Female	4%	6%	15%	29%	33%	14%	3.22	1.26
	Male	1%	4%	8%	27%	28%	33%	3.73	1.17
3. Credibility of the company's management	Female	0%	2%	5%	17%	23%	53%	4.21	1.02
	Male	0%	1%	3%	7%	23%	67%	4.52	0.82
4. Court cases	Female	1%	5%	14%	27%	26%	28%	3.54	1.23
	Male	1%	5%	12%	31%	31%	19%	3.43	1.15
5. Penalties and fines	Female	1%	3%	8%	24%	35%	30%	3.77	1.11
	Male	1%	5%	14%	27%	31%	22%	3.49	1.18
6. Honours and awards	Female	7%	8%	14%	26%	24%	22%	3.17	1.48
	Male	10%	17%	20%	30%	16%	6%	2.43	1.38
7. Press releases about the company and opinions on web portals	Female	6%	3%	7%	20%	36%	29%	3.62	1.36
	Male	3%	14%	18%	33%	19%	13%	2.90	1.31
8. Company's involvement in socially responsible activities	Female	2%	9%	16%	20%	28%	26%	3.40	1.36
	Male	16%	20%	23%	22%	12%	7%	2.14	1.47

Source: own work.

In order to determine the statistical significance of differences between the answers of men and women, the Kruskal-Wallis test and the Dunn test were performed (Table 6).

**Table 6.***The results of the Kruskal-Wallis and Dunn tests – gender differences*

Criterion	Gender	Kruskal-Wallis test			Dunn's procedure	
		Mean of ranks	p-value	Accepted hypothesis	Groups	
1. Shareholders' structure	Female	204.41	0.647	H0	A	
	Male	210.47			A	
2. Policy of majority shareholders towards minority shareholders	Female	172.09	0.000	Ha		B
	Male	220.80			A	
3. Credibility of the company's management	Female	183.15	0.004	Ha		B
	Male	217.26			A	
4. Court cases	Female	218.37	0.353	H0	A	
	Male	206.00			A	
5. Penalties and fines	Female	230.78	0.031	Ha	A	
	Male	202.04				B
6. Honours and awards	Female	255.12	0.000	Ha	A	
	Male	194.26				B
7. Press releases about the company and opinions on web portals	Female	262.23	0.000	Ha	A	
	Male	191.99				B
8. Company's involvement in socially responsible activities	Female	281.76	0.000	Ha	A	
	Male	185.75				B

Source: own work.

According to the obtained results, slight differences for the criteria "Shareholders' structure" and "Court cases" turned out to be statistically insignificant. However, in relation to the remaining criteria, the differences turned out to be statistically significant. "Policy of majority shareholders towards minority shareholders" and "Credibility of the company's management"

are criteria that are more important to male investors, while "Penalties and fines", "Honours and awards", "Press releases about the company and opinions on web portals" and "Company's involvement in socially responsible activities" are aspects rated higher by female investors.

Based on the obtained results, it can be concluded that the hypothesis *H2* ("Women assign higher importance than men to social criteria for assessing the reputation of enterprises") was only partially confirmed (criteria 5-8).

### 4.3 Results By Age

The research results also showed differences in the importance of the analyzed criteria depending on the age of the respondents (Table 7). For some criteria the differences are not significant (e.g. "Shareholders' structure", "Court cases", "Penalties and fines"). For others, the differences are more clear (e.g. Company's involvement in socially responsible activities).

**Table 7.**

*Importance of social reputation criteria – age differences*

Criterion	Age	0	1	2	3	4	5	Mean	Std. deviation
1. Shareholders' structure	<25	3%	7%	19%	35%	26%	10%	3.04	1.19
	25-45	4%	4%	12%	36%	31%	13%	3.24	1.19
	45<	3%	3%	17%	30%	34%	13%	3.30	1.14
2. Policy of majority shareholders towards minority shareholders	<25	2%	6%	19%	30%	25%	17%	3.24	1.23
	25-45	1%	3%	6%	28%	32%	31%	3.77	1.11
	45<	3%	4%	1%	18%	29%	45%	4.01	1.22
3. Credibility of the company's management	<25	0%	1%	5%	16%	28%	50%	4.22	0.94
	25-45	1%	2%	2%	6%	21%	69%	4.52	0.89
	45<	0%	0%	3%	1%	17%	79%	4.72	0.62
4. Court cases	<25	1%	6%	12%	28%	26%	27%	3.55	1.22
	25-45	2%	6%	14%	32%	29%	17%	3.32	1.18
	45<	0%	3%	11%	30%	37%	20%	3.61	1.01
5. Penalties and fines	<25	1%	4%	12%	22%	34%	27%	3.66	1.18
	25-45	1%	6%	16%	27%	28%	23%	3.46	1.19
	45<	1%	4%	7%	32%	36%	21%	3.59	1.10
6. Honours and awards	<25	3%	12%	18%	27%	21%	18%	3.05	1.38
	25-45	16%	18%	15%	32%	16%	3%	2.24	1.42
	45<	9%	12%	26%	28%	17%	8%	2.55	1.37
7. Press releases about the company and opinions on web portals	<25	5%	10%	10%	27%	24%	24%	3.27	1.44
	25-45	4%	13%	19%	29%	22%	13%	2.92	1.34
	45<	1%	9%	18%	37%	24%	11%	3.04	1.16
8. Company's involvement in socially responsible activities	<25	5%	9%	18%	24%	25%	19%	3.12	1.42
	25-45	20%	24%	23%	19%	8%	6%	1.88	1.44
	45<	13%	17%	24%	22%	16%	8%	2.34	1.47

Source: own work.

Statistical significance of differences in respondents' answers due to age was tested using the Kruskal-Wallis and Dunn tests (Table 8).

**Table 8.***The results of the Kruskal-Wallis and Dunn tests – age differences*

Criterion	Age	Kruskal-Wallis test			Pairwise comparisons p-values			Dunn's procedure		
		Mean of ranks	p-value	accepted hypothesis	<25	25-45	45<	Groups		
1. Shareholders' structure	<25	194.43	0.122	H0	1.000	0.073	0.099	A		
	25-45	216.96			0.073	1.000	0.798	A		
	45<	221.02			0.099	0.798	1.000	A		
2. Policy of majority shareholders towards minority shareholders	<25	171.31	0.000	Ha	1.000	0.000	0.000		B	
	25-45	223.52			0.000	1.000	0.052	A		
	45<	254.46			0.000	0.052	1.000	A		
3. Credibility of the company's management	<25	179.27	0.000	Ha	1.000	0.000	0.000		B	
	25-45	220.95			0.000	1.000	0.107	A		
	45<	243.68			0.000	0.107	1.000	A		
4. Court cases	<25	218.65	0.109	H0	1.000	0.064	0.880	A		
	25-45	195.26			0.064	1.000	0.105	A		
	45<	221.10			0.880	0.105	1.000	A		
5. Penalties and fines	<25	220.25	0.215	H0	1.000	0.081	0.561	A		
	25-45	198.17			0.081	1.000	0.427	A		
	45<	210.82			0.561	0.427	1.000	A		
6. Honours and awards	<25	243.27	0.000	Ha	1.000	0.000	0.014	A		
	25-45	180.98			0.000	1.000	0.177		B	
	45<	202.75			0.014	0.177	1.000		B	
7. Press releases about the company and opinions on web portals	<25	228.74	0.022	Ha	1.000	0.007	0.102	A		
	25-45	194.31			0.007	1.000	0.633		B	
	45<	201.99			0.102	0.633	1.000	A	B	
8. Company's involvement in socially responsible activities	<25	261.23	0.000	Ha	1.000	0.000	0.000	A		
	25-45	165.35			0.000	1.000	0.025			C
	45<	201.73			0.000	0.025	1.000		B	

Source: own work.

According to the obtained results, the differences for three criteria, i.e. "Shareholders' structure", "Court cases" as well as "Penalties and fines" turned out to be statistically insignificant. The importance of these criteria is similarly perceived by investors, regardless of their age. In the case of the remaining criteria, the differences between investors in different age groups turned out to be statistically significant. The importance of the criteria: "Policy of majority shareholders towards minority shareholders" and "Credibility of the company's management" increases with the age of the surveyed investors. However, Dunn's test showed a statistically significant difference in the perception of the importance of these criteria between groups of investors aged under 25 and older (25-45 and over 45). The opposite situation applies to the criteria "Honours and awards" and "Press releases about the company and opinions on web portals" – investors under 25 attach more importance to them than older ones. On the other hand, "Company's involvement in socially responsible activities" shows the highest differentiation of importance for different age groups. This criterion turned out to be the most important for the youngest investors (up to 25). Older investors (over 40) considered them less important and aged 25 to 45 the least important.

Based on the presented analysis, hypothesis *H3* ("Social criteria for assessing the reputation of enterprises are most important for young individual investors, i.e. up to 25 years of age") was only partially confirmed (criteria 6-8).

#### 4.4 Results By Investment Experience

The importance of the social aspects of company's reputation also turned out to be differentiated due to the investment experience of the respondents. The smallest dispersion of average significance scores again concerns the criteria "Shareholders' structure" and "Court cases", and the largest criteria "Company's involvement in socially responsible activities" and "Policy of majority shareholders towards minority shareholders" (Table 9).

**Table 9.**

*Importance of social reputation criteria – investment experience differences*

Criterion	Invest. exp.	0	1	2	3	4	5	Mean	Std. deviation
1. Shareholders' structure	<1	4%	6%	16%	36%	27%	10%	3.06	1.21
	1-5	4%	3%	21%	31%	27%	14%	3.15	1.24
	5-10	6%	6%	11%	40%	28%	9%	3.08	1.24
	10<	1%	4%	12%	32%	37%	14%	3.41	1.06
2. Policy of majority shareholders towards minority shareholders	<1	2%	7%	16%	36%	26%	13%	3.15	1.17
	1-5	4%	3%	10%	23%	30%	31%	3.63	1.32
	5-10	2%	2%	2%	19%	38%	38%	4.02	1.07
	10<	0%	3%	3%	21%	28%	45%	4.10	1.01
3. Credibility of the company's management	<1	0%	1%	5%	15%	30%	49%	4.22	0.93
	1-5	1%	3%	1%	11%	20%	63%	4.35	1.08
	5-10	0%	2%	4%	4%	19%	72%	4.55	0.89
	10<	0%	0%	1%	1%	17%	81%	4.79	0.49
4. Court cases	<1	1%	5%	12%	28%	28%	27%	3.59	1.17
	1-5	1%	6%	10%	31%	35%	17%	3.44	1.14
	5-10	2%	6%	11%	23%	40%	19%	3.49	1.20
	10<	1%	6%	16%	36%	24%	17%	3.27	1.16
5. Penalties and fines	<1	1%	3%	10%	23%	33%	30%	3.72	1.15
	1-5	0%	4%	17%	24%	35%	20%	3.49	1.12
	5-10	2%	2%	13%	26%	32%	25%	3.58	1.17
	10<	1%	8%	14%	31%	28%	19%	3.34	1.20
6. Honours and awards	<1	4%	13%	15%	27%	23%	19%	3.09	1.41
	1-5	13%	15%	23%	27%	20%	3%	2.34	1.37
	5-10	15%	23%	21%	23%	13%	6%	2.13	1.45
	10<	14%	15%	20%	37%	13%	3%	2.28	1.32
7. Press releases about the company and opinions on web portals	<1	4%	10%	10%	30%	21%	25%	3.30	1.41
	1-5	4%	11%	23%	27%	24%	11%	2.89	1.33
	5-10	2%	19%	13%	38%	21%	8%	2.79	1.25
	10<	4%	9%	20%	28%	26%	12%	2.99	1.31
8. Company's involvement in socially responsible activities	<1	5%	9%	19%	20%	26%	21%	3.16	1.45
	1-5	18%	14%	21%	28%	13%	6%	2.20	1.47
	5-10	32%	11%	28%	25%	2%	2%	1.58	1.32
	10<	13%	34%	21%	18%	9%	4%	1.90	1.34

Source: own work.

The statistical significance of differences in respondents' assessments due to their investment experience was tested using the Kruskal-Wallis and Dunn tests. The test results are shown in Table 10.

**Table 10.**

*The results of the Kruskal-Wallis and Dunn tests – investment experience differences*

Criterion	Invest. exp.	Kruskal-Wallis test			Pairwise comparisons p-values				Dunn's procedure		
		Mean of ranks	p-value	Accepted hypothesis	<1	1-3	3-5	10<	Groups		
1. Shareholders' structure	<1	197.57	0.095	H0	1.000	0.607	0.831	0.014		B	
	1-5	205.95			0.607	1.000	0.831	0.144	A	B	
	5-10	201.45			0.831	0.831	1.000	0.118	A	B	
	10<	231.46			0.014	0.144	0.118	1.000	A		
2. Policy of majority shareholders towards minority shareholders	<1	161.19	0.000	Ha	1.000	0.001	0.000	0.000			C
	1-5	215.60			0.001	1.000	0.095	0.016		B	
	5-10	250.91			0.000	0.095	1.000	0.715	A	B	
	10<	257.94			0.000	0.016	0.715	1.000	A		
3. Credibility of the company's management	<1	178.14	0.000	Ha	1.000	0.057	0.003	0.000			C
	1-5	205.75			0.057	1.000	0.279	0.005		B	C
	5-10	225.99			0.003	0.279	1.000	0.165	A	B	
	10<	249.70			0.000	0.005	0.165	1.000	A		
4. Court cases	<1	221.47	0.119	H0	1.000	0.389	0.738	0.017	A		
	1-5	207.35			0.389	1.000	0.705	0.279	A	B	
	5-10	215.36			0.738	0.705	1.000	0.162	A	B	
	10<	188.37			0.017	0.279	0.162	1.000		B	
5. Penalties and fines	<1	226.27	0.039	Ha	1.000	0.114	0.411	0.005	A		
	1-5	200.36			0.114	1.000	0.606	0.454	A	B	
	5-10	211.26			0.411	0.606	1.000	0.213	A	B	
	10<	187.24			0.005	0.454	0.213	1.000		B	
6. Honours and awards	<1	247.20	0.000	Ha	1.000	0.000	0.000	0.000	A		
	1-5	187.36			0.000	1.000	0.413	0.780		B	
	5-10	169.85			0.000	0.413	1.000	0.520		B	
	10<	182.41			0.000	0.780	0.520	1.000		B	
7. Press releases about the company and opinions on web portals	<1	229.32	0.018	Ha	1.000	0.022	0.011	0.044	A		
	1-5	191.49			0.022	1.000	0.671	0.587		B	
	5-10	182.44			0.011	0.671	1.000	0.338		B	
	10<	201.09			0.044	0.587	0.338	1.000		B	
8. Company's involvement in socially responsible activities	<1	264.02	0.000	Ha	1.000	0.000	0.000	0.000	A		
	1-5	191.68			0.000	1.000	0.029	0.149		B	
	5-10	144.64			0.000	0.029	1.000	0.279			C
	10<	165.91			0.000	0.149	0.279	1.000		B	C

Source: own work.

The previously signalled slight differences for the "Shareholders' structure" and "Court cases" criteria turned out to be statistically insignificant in the Kruskal-Wallis test. However, Dunn's test showed some statistically significant differentiation. The "Shareholders' structure" criterion is more important for the most experienced investors, and the "Court cases" criterion – for the least experienced investors. A relatively small differentiation of significance, although statistically significant from the point of view of the Kruskal-Wallis test, is also found in "Penalties and fines". This criterion is more important for the least experienced investors. The least experienced investors attach much more importance to the criteria of "Honours and

awards" and "Press releases about the company and opinions on web portals" compared to investors with more experience. The criteria "Policy of majority shareholders towards minority shareholders", "Credibility of the company's management" and "Company's involvement in socially responsible activities" show the greatest diversity in the respondents' assessments. The more experienced the investor, the higher he assesses the importance of "Policy of majority shareholders towards minority shareholders" and "Credibility of the company's management". On the other hand, the less experienced the investor, the more he appreciates "Company's involvement in socially responsible activities". In particular, this criterion is slightly more important for the most experienced investors (10<) compared to investors with 5-10 years of experience.

Based on the above analysis, it can be concluded that hypothesis *H4* ("Social criteria for assessing the reputation of enterprises are more important for experienced individual investors, i.e. over 10 years of activity") was also only partially confirmed (criteria 1-3).

## 5. Discussion

The obtained results showed that the company's social commitment is not very important for individual investors (hypothesis *H1*), which seems to contradict some current trends described in the literature and research results that the importance of the company's social commitment for investors is growing (Ioannou, Serafeim, 2015; Eccles, Klimenko, 2019). This may be due to the fact that the issues of "socially responsible activities" or CSR, in the context of enterprises, are often associated in Poland only with charitable activities of enterprises or sponsorship and considered a manifestation of a kind of financial mismanagement (Pawnik, 2018). Other explanations may be: lack of confidence in the positive reaction of customers to CSR activities undertaken by enterprises and the short-term perspective of individual investors, which causes reluctance to spend on social purposes (Erhemjamts and Huang, 2019).

Research has also shown that female investors are generally more sensitive to the social aspects of reputation than men (*H2* hypothesis). Out of 8 analyzed social criteria for assessing the reputation of enterprises, in the case of 4, higher significance was indicated by women, in the case of 2, women and men perceived significance similarly, and in 2, higher significance was indicated by men. It should be added that men's scores were higher for elements that could be associated with corporate governance ("Policy of majority shareholders towards minority shareholders" and "Credibility of the company's management"), while women's scores were higher for i.a. socially responsible activities. The results obtained correspond to the results of a study in the United States (Nath et al., 2013).

The H3 hypothesis, which says that younger investors are more sensitive to social aspects of reputation, has also been partially confirmed. Out of 8 analyzed social criteria for assessing corporate reputation, in the case of 3, higher significance was indicated by younger investors (up to 25 years), in the case of 3, investors of different ages perceived significance similarly, and in 2, higher significance was indicated by older investors (over 45 years). These results are consistent with the research cited in the theoretical part (Nel et al., 2021; Wang et al., 2020; de la Ville, 2014).

The H4 hypothesis, that social aspects of reputation are more relevant to seasoned individual stock investors, has not been confirmed. Out of 8 analyzed social criteria for assessing corporate reputation, in the case of 3, higher significance was indicated by investors with extensive experience (over 10 years), and in the case of 5 by investors with medium and less experience. For investors with more investment experience, the most important The same criteria turned out to be the same as in the case of men and older investors ("Policy of majority shareholders towards minority shareholders" and "Credibility of the company's management and additionally "Shareholders' structure". Socially responsible activities were rated the highest by investors with the least experience.

## 6. Conclusions

The presented research concerned the answer to the question: how individual investors assess the importance of social aspects of the company's reputation from the point of view of their investment decisions. The surveyed sample consisted of 417 investors operating on the Polish financial market. The research concept was based on a theoretical background, including stakeholder theory (Soleimani et al., 2014; Gao et al., 2017), signaling theory (Hetze, 2016), institutional theory (Deephouse et al., 2016) and concepts of the reputation model (Rathel, Schwaiger, 2005; Lange et al., 2011). By distinguishing eight social criteria for assessing the reputation of joint-stock companies, we examined their importance for investors due to three characteristics: gender, age and investment experience (Table 11).

The first three societal criteria for assessing reputation are most relevant to male investors, older investors (over 45 years old) and more experienced investors (over 10 years old). On the other hand, the remaining five criteria are more important for female investors, young investors (below 25 years old) and inexperienced investors (less than 1 year old).

**Table 11.**  
*Overall results*

Criterion	Gender	Age (years)	Investment experience (years)
1. Shareholders' structure	All	All	10<
2. Policy of majority shareholders towards minority shareholders	Male	45<	10<
3. Credibility of the company's management	Male	45<	10<
4. Court cases	All	All	<1
5. Penalties and fines	Female	All	<1
6. Honours and awards	Female	<25	<1
7. Press releases about the company and opinions on web portals	Female	<25	<1
8. Company's involvement in socially responsible activities	Female	<25	<1

Source: own work.

### Contributions and practical implications

Our study contributes to the literature both theoretically and methodologically. Firstly, it is in line with earlier research indicating the growing importance of reputation (Helm, 2007b; Baumgarten et al., 2020; Blajer-Gołębiowska, 2019) and its social aspects, mainly CSR (Aaron et al., 2012; Cordeiro, Tewari, 2015; Ioannou, Serafeim, 2015) as decision criteria for investors. The results of our research broaden and supplement the knowledge on this subject in relation to individual investors, indicating that the gender, age and investment experience of investors are important when assessing the social aspects of a company's reputation. For women and younger and less experienced investors, the following are more important: penalties and fines paid by the company, awards and distinctions obtained, opinions about the company in the press or on Internet portals, and the company's social involvement. These conclusions confirm and at the same time complement the research of other authors in this area (Nel et al., 2021; Wang et al., 2020; de la Ville, 2014; Eng-Tuck Cheah et al., 2011).

Secondly, the obtained results contribute to the agency theory (Bendickson et al., 2016), confirming the attitude and expectations of individual investors towards company management boards. Well, by far the most important criterion out of the eight highlighted for the surveyed investors turned out to be "Credibility of the company's management". The next places were: "Policy of majority shareholders towards minority shareholders" and "Penalties and fines" and "Court cases". These results reveal that individual investors prioritize securing their own interests and benefits. It is worth noting that such attitudes prevail among male investors and older investors with more experience.

Thirdly, in our research we specify the social aspects of reputation by indicating eight criteria that can be measurably assessed by investors. These criteria are based on the data included in the reports of listed companies. In previous studies on the importance of social motives for investors' decisions, the authors relied on published rankings (Minor, Morgan, 2011; Adamska, Dąbrowski, 2016; Cordeiro, Tewari, 2015) or analyzed the importance of selected, individual aspects (Gödker, Mertins, 2018; Shen et al., 2017). Our approach can



therefore contribute to the development of methodology for studying the motivation and behavior of stock market investors.

Finally, our study addresses the problem of reporting non-financial information about the company, in particular CSR data. So far, no international standards for reporting these data have been developed (Tschopp, Nastanski, 2014). In view of the global challenges of sustainable development and the growing pressure of many stakeholder groups (especially investors), the establishment of such standards becomes necessary. The eight criteria for evaluating the social aspects of reputation proposed in our research may serve as inspiration and guidelines for formulating such standards.

From the perspective of reputation management, research results can be useful for formulating effective strategies, as they indicate priority social aspects for investors. For older and more experienced investors, the priority is the credibility of the management board, policy towards shareholders, avoiding court cases and related financial penalties. Younger investors attach more importance to the company's commitment to society and the environment, and to the company's appreciation by various bodies (awards and distinctions, opinions in the media). It can therefore be assumed that the importance of these criteria will increase over time.

Our research also has some social implications. The obtained results show how important socially responsible activities of enterprises are from the point of view of the key group of stakeholders, i.e. investors. Therefore, they can be a suggestion and motivation for companies to intensify their activities and undertake initiatives beneficial for society and the environment.

### **Limitations and future research directions**

Our research is limited to individual investors from one country only. Therefore, the obtained results cannot be generalized and treated as representative for this group of investors. However, they can be an inspiration for research in other countries, both with a similar degree of development of the financial market (e.g. V4) and slightly higher (Spain, France, Germany). Second, similar research can be conducted among other groups of investors (e.g. institutional investors divided into large and marginal ones) to compare their attitudes to the importance of reputation and its social aspects.

Another limitation of the research is the imprecise formulation of the criterion of "socially responsible activities", which could be associated by the respondents only with charitable activities. In subsequent studies, this question should be clarified by separating the company's activities for specific stakeholder groups (employees, local communities, charities, etc.).

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## ENHANCING ORIENTATION AND SENSITISATION FOR INFORMED CAREER CHOICES FOR CAMEROONIAN UNIVERSITY STUDENTS

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**Purpose:** this study examines the escalating issue of graduate unemployment and underrepresentation in certain academic programmes in Cameroon. It aims to evaluate the effectiveness of orientation and sensitisation programmes at Cameroonian universities and their impact on students' career development and choices.

**Design/methodology/approach:** using a descriptive survey methodology, the study engaged 200 students across various universities and disciplines in Cameroon. The research employed both online and in-person questionnaires, with data analysis combining descriptive statistics, correlation analysis and ANOVA to assess perspectives across institutions.

**Findings:** the results highlight a significant lack of adequate career orientation and sensitisation among students, revealing disparities in the quality of orientation and the need for improved career guidance strategies.

**Research limitations/implications:** while the study offers valuable insights, it acknowledges the limitations of its focus on specific universities and survey-based data collection. It suggests further research into the barriers to effective guidance and the long-term impact of orientation programmes.

**Practical implications:** the study underscores the need for universities to enhance orientation programmes involving expert collaboration and online platforms to ensure students make informed career decisions.

**Social implications:** addressing orientation disparities, particularly in rural areas, is critical for equitable access to career guidance, which has implications for social equality and quality of life improvements.

**Originality/value:** this paper contributes new insights into the impact of orientation and sensitisation on students' career choices within the Cameroonian context, offering a foundation for future policy and educational practice enhancements.

**Keywords:** student orientation, sensitisation, career choices, universities, Cameroon.

## 1. Introduction

For myself, Yaje and Gooh, as well a majority of Cameroonian students, the transition from secondary school to university is one of the most challenging stages in our academic and professional career development. Unlike elsewhere such as in South Africa, where roughly 90% of university education graduates are expected to find work (Walker, Mathebula 2020, p. 1194), the situation in Cameroon is significantly different. Despite a decrease in unemployment rate, from 7.00% in 2021 to 6.87% in 2022, youth unemployment in Cameroon remains persistently high (Macrotrends, 2023). Although Achankeng et al. (2023, pp. 19-20) found that a majority of the students in state universities in Cameroon, for example, receive adequate academic support in their first year of enrollment as part of the transition facilitation process; it is rather unfortunate that this support is often only limited to helping the students adjust to their new environment emotionally and psychologically. In other words, many counsellors across universities in Cameroon focus on helping new students relate with friends, address issues related to Continuous Assessments (CAs), personal belongings and health (Achankeng et al., 2023). While orientation for health and psychological wellbeing is equally important, exclusive focus on it seems contrary to the primary and longstanding tradition of a majority of universities that conduct orientation and sensitisation programmes with the objective of reshaping and serving students to make decisions concerning their career trajectories (Chen et al., 2022; Ngope, Coetzee, 2023; Ramnund-Mansingh, Seedat-Khan, 2020). This partly explains why the orientation and sensitisation of students in Cameroon may not have significantly contributed to resolving challenges related to academic and career choices at the university level, even though it starts early on in secondary school. Even with every secondary school and university equipped with a guidance counsellor, there has been arguably insufficient evaluation in the academic literature of the influence of effective career orientation and sensitisation for university students in Cameroon on their subsequent career trajectories. Abubakar (2018, p. 17) confirms this argument by stating as follows:

*The implications of poor participation in career guidance activities could have both short- and long-term effects on the students' career decisions on the one hand and on the quality of labour to be produced through the process on the other. In the short run, low participation in career guidance prevents students from making considered career decisions based on personality variables such as skills, values, aptitude, and so forth, resulting in competency mismatch.*

Contestably, what may be called injudicious orientation and sensitisation are one of the causes of lower percentages of graduates in specific fields (e.g., software engineering), frequent programme changes, and a notable disproportion between the number of students admitted and those who eventually graduate from specific departments in Cameroon's higher education institutions. As a result, this paper explores the impact of effective student orientation and

sensitisation on students' career choices. We start by discussing the scholarly literature on orientation and sensitisation and their importance to students' career choices as it relates to Cameroon. We next discuss the obstacles that Cameroonian universities face, such as dropout rates, frequent programme changes and preferences for particular programmes by students, to determine whether these are due to inadequate and poor student career orientation and sensitisation of students. We then attempt to integrate the Social Cognitive Career Theory (SCCT) into the subject of career orientation and sensitisation and its impact on students' career choices in the Cameroonian context. We used a descriptive survey methodology with 200 participants to frame the situation in Cameroon, emphasising the importance of improved orientation and sensitisation in empowering students to make informed career choices with long-term beneficial for educational policy and practise on professional career development.

## **2. Literature on career orientation and sensitisation**

Extensive academic literature already exists on the subject of career orientation and sensitisation on a global, regional and even country and even university level. These literatures tackle issues of the influence of career orientation and sensitisation on transition from secondary school to university (Achankeng et al., 2023), retention and academic success rates of students (Cavalletti, 2021; Bradford, 2017), industry-specific needs such as leadership behaviour in the medical and transport industries (Cabras, Mondo, 2018) and switching from one programme or university to the other (Hale, 2019), among others. As stated by Martin et al. (2018) and Mauritti et al. (2023), making well-informed career choices has led to increased emphasis on effective orientation and sensitisation strategies within educational institutions, providing justification for both the inevitability and vitality of orientation and sensitisation programmes for university students over the years. Interestingly, orientation and sensitisation programmes have emerged as fundamental tools in helping students to navigate the intricate pathways of education and professional career development during and after studies as part of the preparation for graduate studies and lifelong learning (Gardiner, Juras, 2019; McNair, Bonneville, 2021; Warner-Gryphon et al., 2023). While orientation involves the systematic provision of information about academic programmes, campus resources and support services, ensuring that students possess the necessary knowledge to make informed decisions consistent with their career choices (Sullivan, 2021; Jonson et al., 2022), sensitisation, on the other hand entails the process of raising awareness among students about the diverse career choices available to them, enabling them to explore and understand the breadth of opportunities across various fields (Brown, Lent, 2005). Consequently, career orientation and sensitisation seem inherently intertwined and are both necessary to see students through the journey of making the best out of their intelligence while at the university.

Multiple research works also underline the central role of orientation in influencing students' career decisions. For instance, adequate orientation has been linked to heightened academic engagement in recent years, improved retention rates and enhanced career satisfaction by Brown and Krane (2000) Brown et al. (2003) and Brown and Lent (2005). Students who undergo effective orientation programmes tend to exhibit a clearer understanding of their academic pursuits and career aspirations, consequently increasing the likelihood of aligning their programme choices with their envisioned professional paths (Abubakar, 2018; Langher et al., 2018). Thus, the value of orientation lies not only in facilitating academic integration but also in fostering the formation of well-informed career goals for these students. Another important point is that the orientation needs of students are often influenced by their educational backgrounds. International students, for example, may require tailored orientation strategies to navigate unfamiliar academic and cross-cultural transitions that can be very challenging (Newsome, Cooper, 2016; Bethel et al., 2020, p. 1). Even within the Cameroonian context, the ethnic construct of the country with students often coming from as many as 250 diverse ethnic groups require careful consideration. Moreover, the extent of students' prior exposure to career-related information can significantly impact the effectiveness of orientation programmes. Students with limited prior knowledge about various career options may profoundly benefit from comprehensive orientation programmes that provide them with a broader understanding of potential pathways (Kuh et al., 2006; Njogu, 2019; Darling-Hammond et al., 2020). Another factor addressed by Nyakundi and Orodho (2020) is the geographical context within which students are situated plays a pivotal role in shaping their perceptions of career opportunities. In Cameroon, as in numerous other countries, students' access to information and resources is often contingent upon their geographical location. Urban areas typically offer greater exposure to diverse career options and resources compared to rural areas (Sanfo, 2023). This disparity shapes the importance of considering the geographical context when designing orientation and sensitisation strategies, as the availability and effectiveness of resources can vary significantly based on location.

A study conducted on Kumba, a town in the South West Region of Cameroon by Bama and Borokonda (2019) brought to light the significant impact of career orientation and sensitisation on students' ultimate career choices in secondary schools. The study revealed the following (Bama, Borokonda, 2019, p. 311):

*Career information provided by school and career counsellors in the context of career guidance positively enhances learners' choice of career; career fairs organised on school campuses by resident school or career counsellors in the context of career guidance positively impact the choices that students make of their careers as these fairs enable students to make suitable and informed career decisions, which could have lifelong optimistic effects on their lives; and school career days have a very positive incidence on students' career choice.*

As a result, it may be enough to assert that career orientation and sensitisation are an essential environmental influence in assisting learners in making appropriate professional choices in their lives. Shumba and Naong (2012) conducted another study to determine the characteristics that influence South African students' job preferences and goals. The home environment, the individual learner's ability to define their intended professional route, and the role of instructors in shaping students' career paths were identified as significant factors in this study. Furthermore, data from research done in Uganda by James and Denis (2015) found that students typically base their career choices on their own experiences and interests (30.2%), as well as familial influences (15.5%). Another study undertaken in the South African setting by Abe and Chikoko (2020) revealed a unique viewpoint that underlined the crucial roles that families, personality traits and external expectations play in the complicated process of professional decision-making. The significance of these studies lies not in their existence per se, but in their generalisability and the lessons they offer in terms of career orientation and sensitisation in their individual countries, educational settings of other African countries and the world as a whole.

## **2.1. Knowledge gaps**

Whereas the above literature demonstrate that several studies, including those by Achankeng et al. (2023), Bama and Borokonda (2019) and Sanfo (2023), have already been conducted and have emphasised the significance of career orientation and sensitisation in shaping informed decisions among students outside of and within Cameroon's educational sector, these studies have failed to address the issue of the value effective career orientation and sensitisation have for students with the context of the Cameroonian university. The study conducted by Achankeng et al. (2023), for example, sheds light on the correlation between academic support and the social adjustment of newly enrolled students in state universities in Cameroon. Nevertheless, it fails to show how orientation and sensitisation programmes during studies can help students to better prepare for their professional careers. Also, informal workplace learning contributes intensively to the growth of individual skills and career advancement Muzam et al., (2023). Unfortunately, it is only becoming popular in Cameroon now furthering emphasising timeliness of this study.

Similarly, the study by Mkong et al. (2019) provides insights into factors influencing career choices among Cameroonian university students in the agricultural sector. However, several knowledge gaps remain. To begin with, there is a need for a more in-depth exploration of the reasons behind students' perceptions of employment opportunities in agriculture and the impact of societal attitudes on career decisions. The study should also consider the influence of cultural and regional variations in a diverse country like Cameroon. Furthermore, analysing the effectiveness of existing orientation efforts and identifying barriers to their success can enhance the study's insights. Exploring the role of digital platforms and modern communication channels in shaping career perceptions and choices should also be integrated for a holistic

perspective. A study conducted by Mah (2023) indicated that knowledge gap exists in the education system, political sector, economic and social system due to a systematic racism in Cameroon. Essential knowledge ends up unnoticed due to systematic racism and favoritism which go a long way to negatively impact career orientation and sensitization choices.

The study conducted by Bama and Borokonda (2019) adds to our understanding of career guidance's impact on students' choices within a specific Cameroonian region. Yet significant knowledge gaps persist. A deeper understanding of the mechanisms through which career information and guidance activities affect students' decisions is essential. Exploring the psychological processes underlying information processing and internalisation can enrich the study. Investigating obstacles that hinder effective access and utilisation of career guidance services would provide valuable context. Additionally, a comparative analysis of diverse guidance interventions could yield nuanced insights. Lastly, the long-term effects of career guidance activities on students' career paths and job satisfaction remain unexplored and should be pursued for a comprehensive grasp of the subject.

In order to advance a comprehension of enhancing the quality and necessity of orientation and sensitisation for informed career choices among Cameroonian university students, addressing these knowledge gaps became imperative to us. Our study delves into these areas and marks a pioneering attempt to examine the impact of the quality and influence of orientation and sensitisation on university students in Cameroon, employing the Social Cognitive Career Theory (SCCT) as its guiding framework.

## **2.2. Social Cognitive Career Theory (SCCT)**

The theoretical framework that underpins this study is the Social Cognitive Career Theory (SCCT), as proposed by Lent, Brown, and Hackett (1994). This theory forms a pivotal foundation for understanding how orientation and sensitisation programmes influence students' career decisions within the context of Cameroonian universities. SCCT emphasises the interplay of personal factors, contextual cues, and self-efficacy beliefs in shaping individuals' career choices. The central objective of this study was to examine the impact of orientation and sensitisation programmes on the career decisions of university students in Cameroon. To comprehensively address this objective, it was imperative to delve into the factors and mechanisms that guide students' career choices. SCCT aligns seamlessly with that objective by providing a robust theoretical lens through which to analyse how orientation programmes contribute to students' self-efficacy beliefs, ultimately influencing their career decisions. The way we think determines the way we act and the way we act is based on how we think Mah et al. (2023). Self-efficacy and self-esteem have greatly impact career orientation and sensitisation amongst university students in Cameroon. The study conducted by Mah et al. (2023) helps us to understand that our thoughts have an important role in our career choices and the actions we take.



In the broader context of the literature review, SCCT offered insights into the significance of making well-informed career choices, which have led to an increased emphasis on effective orientation and sensitisation strategies within educational institutions (Martin et al., 2018; Mauritti et al., 2023). This theoretical framework substantiates the argument that orientation plays a fundamental role in helping students navigate the complex pathways of education and career development (Constance, 2019; McNair, Bonneville, 2021; Warner-Gryphon et al., 2023). Additionally, SCCT elucidates that sensitisation raises awareness among students about diverse career options, enabling them to explore and understand opportunities across various fields (Brown, Lent, 2004).

The role of SCCT is particularly pronounced in understanding the impact of orientation on career choices. Extensive research underscores how orientation enhances academic engagement, retention rates, and career satisfaction (Brown, Krane, 2000; Brown et al., 2003; Brown, Lent, 2005). Students who undergo effective orientation programmes exhibit a clearer understanding of their academic pursuits and career aspirations, aligning their choices with envisioned professional paths (Abubakar, 2018; Langer et al., 2018). Thus, SCCT emphasises that orientation facilitates academic integration and fosters well-informed career goals. SCCT also accentuates the influence of educational background on orientation needs. International students and those with limited prior knowledge about career options may significantly benefit from comprehensive orientation programmes that broaden their understanding of potential pathways (Kuh et al., 2006; Nyamwange, 2016; Darling-Hammond et al., 2020). The theoretical framework, therefore, underscores the relevance of considering students' diverse backgrounds in designing effective orientation and sensitisation strategies.

SCCT was seamlessly integrated into the study's data collection and analysis. SCCT's focus on self-efficacy beliefs aligns with the study's exploration of students' perceptions regarding the impact of proper orientation on their career choices. By employing a Likert-type scale to assess students' agreement or disagreement with statements about the influence of orientation, the study aligns with SCCT's emphasis on individuals' beliefs shaping their career decisions. The study's results mirror the predictions of SCCT, with a substantial number of students believing that they could have chosen better career paths with proper orientation. This finding underscores the theory's premise that self-efficacy beliefs play a pivotal role in career decision-making. Moreover, the study's exploration of the influence of school location on orientation quality resonates with SCCT's recognition of contextual cues affecting career choices. The findings highlight the need for nuanced orientation strategies that consider both students' perceptions and the actual impact of location.

Finally, our integration of the Social Cognitive Career Theory (SCCT) into this study's framework provides a comprehensive understanding of how orientation and sensitization programmes influence the career decisions of Cameroonian university students. SCCT's emphasis on self-efficacy beliefs, personal factors, and contextual cues aligns seamlessly with the study's objectives, literature review, research methodology, and findings.

This theoretical framework serves as a guiding lens through which to analyse the intricate relationships between orientation, career choices, and students' backgrounds, contributing to the broader discourse on educational policy and practice.

### 3. Research method

The study employed a descriptive approach that used the survey method to understand various aspects of the student population within the University of Bamenda (UBa), the University of Buea (UB), and other universities in Cameroon. To ensure unbiased representation, a completely randomised sampling design was adopted. This allowed for the participation of a total of 171 students from diverse academic backgrounds, including undergraduates, master's students and others in an online survey administered through Google forms. This questionnaire was meticulously designed to encompass a range of questions pertinent to the study's focus. To ensure comprehensive coverage and participation, the questionnaire was disseminated through various school-affiliated social media groups, primarily on platforms like WhatsApp and Telegram. Additionally, acknowledging the importance of an inclusive approach, the questionnaire was also distributed in a physical format to 29 students on the University of Buea campus. This strategy aimed to engage students who might have had limited online access or who preferred a more traditional method of response. The responses gathered through both the online and offline channels were meticulously recorded to facilitate subsequent analysis.

The questionnaire featured a set of carefully formulated questions that delved into the subject matter. The hybrid approach to questionnaire distribution, involving both online and offline methods, further enhanced participation and accuracy in data collection. The collected data subsequently underwent rigorous analysis, leading to valuable insights that could contribute to informed decision-making and a deeper comprehension of the educational landscape in Cameroon with regards to the quality and value of orientation and sensitisation of students on their career choices.

Below are details on the survey's logistics:

- The total number of participating students is 200.
- Duration of the survey (one month to two months, etc.)

Out of the questions, seven were designed in the Likert-type scale format. The analysis of the collected data encompassed various techniques, including descriptive statistics, correlation analysis, and analysis of variance (ANOVA). To assess disparities in viewpoints across distinct higher education institutions such as University of Buea, The University of Bamenda and a host of other private institutions. The ANOVA was carried out based on the following categorised treatments:

1. Number of students who never had proper orientation.
2. The number of students who believed the location of their school influenced the level of orientation and sensitisation they received.
3. Number of students who believe they would have chosen something else if they were properly oriented.
4. Number of students who agreed that those in the interior have little or no proper orientation.

## 5. Findings of the study

The majority of respondents were from the University of Buea (59%) and The University of Bamenda (22.5%), indicating the prominence of these institutions. Undergraduates constituted 78% of participants, followed by master's students (13%). Notably, 60% reported inadequate orientation before enrolling. While 65% believed proper orientation could have led to better career choices, 33% disagreed. Location played a role; 66.5% received A-level education in major towns. Over half of the students linked school location to orientation quality. Suggestions included expert involvement and online platforms. The study places emphasis on the need for inclusive orientation strategies to bridge regional disparities.

### 5.1. University attendance and background

The results indicate that the respondents were primarily from two universities: the University of Buea (UB) and the University of Bamenda (UBa), with a small portion from other institutions. Among the students surveyed, 59% were from UB, 22.5% were from UBa, and 18.5% were from other universities. This distribution highlights the dominance of these universities in the sample, emphasising the need for tailored orientation strategies.

#### 5.1.1. Educational Levels

The study captured a diverse representation of academic levels among respondents. The majority of participants were undergraduates (78%), followed by master's students (13%), and a smaller portion were classified as "other" (9%). This distribution reflects the enrollment composition of the surveyed universities, suggesting that the findings can be generalised to a broader student population within these institutions.

#### 5.1.2. Orientation and sensitisation

The research investigated whether students had proper orientation before enrolling in university programs. The results reveal that 40% of respondents had received proper orientation, while a larger portion (60%) reported having little or no orientation. This disparity raises concerns about the effectiveness of the orientation processes in place and suggests the need for improvement to ensure that all students receive comprehensive information.

#### *5.1.3. Perception of career choice impact*

The participants' perceptions regarding the impact of proper orientation on their career choices were explored. A majority of students (65%) agreed that they could have chosen something better if they had been properly oriented. However, 35% disagreed, indicating that a significant portion of students felt their initial choices were appropriate despite lacking proper orientation.

#### *5.1.4. A-Level education location*

The study delved into whether the location of students' A-level education influenced their orientation and sensitisation. The results show that 66.5% of respondents completed their A-level education in major towns in Cameroon, while 33.5% completed it in the interior regions. This distinction prompts the question of whether students from different locations receive varying levels of orientation and information about career choices.

#### *5.1.5. Influence of school location*

The survey aimed to determine if students believed their school's location had an impact on their level of orientation and sensitisation. Among the respondents, 55% answered "yes", indicating they perceived a link between school location and the quality of orientation. Additionally, 24% responded with "maybe", and 33% chose "no". This diverse range of responses highlights the need for a nuanced approach to orientation strategies, accounting for both students' perceptions and the actual impact of location.

### **5.2. Suggestions for improving orientation**

Students were given the opportunity to suggest ways to enhance orientation and sensitisation for secondary and high school students in the Anglophone region of Cameroon. A recurring theme in the responses was the involvement of experts and university representatives. Several suggestions included forming expert teams to visit schools, involving university students in orientations, and providing online platforms for information dissemination. These suggestions underline the importance of collaborative efforts and multi-faceted approaches to improving orientation.

### **5.3. Perception of village orientations**

The study explored students' perceptions of the orientation received by students in rural areas. A significant majority of respondents agreed (77%) or strongly agreed (119%) that students in most Cameroonian villages receive little to no proper orientation. This collective sentiment reinforces the urgency of addressing orientation disparities across various regions.

**Table 1.***University attendance*

Category	Frequency	Percent
University of Buea	118	59
University of Bamenda	45	22.5
Other	37	18.5

**Table 2.***Level of education of respondents*

Category	frequency	Percent
Undergraduates	156	78
Master's students	26	13
Other	18	9

**Table 3.***Orientation and sensitisation status before enrolling in the university*

Characteristic	frequency	Percent
Had proper orientation	80	40
Had little or no orientation	120	60

**Table 4.***Respondents could have chosen something better if they were properly oriented*

Category	frequency	Percent
Agree	130	65
Disagree	70	35

**Table 5.***Location where they had GCE A-level*

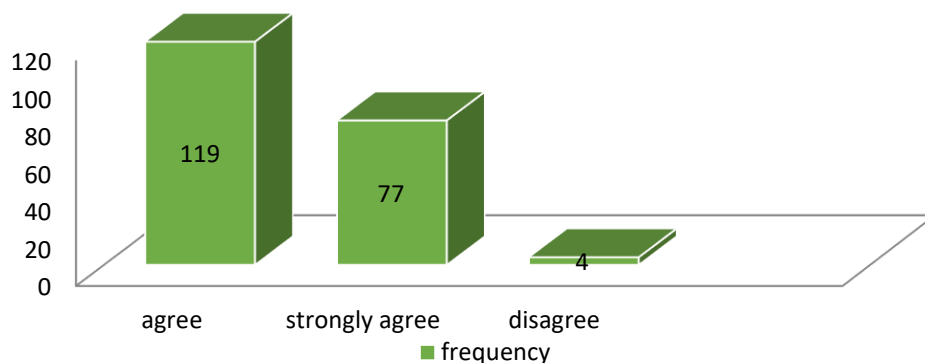
Characteristic	frequency	Percent
In a major town in Cameroon	133	66.5
Other	67	33.5

**Table 6.***Table used for analysis of variance*

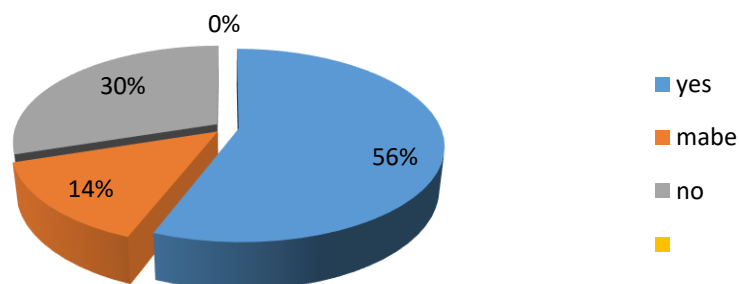
Replicates\groups	UB	UBa	Others
I	62	27	31
II	42	37	42
III	67	32	36
IV	83	55	58

**Table 7.***Analysis of variance (one way ANOVA)*

Source of variation	Degree of freedom	Sum of squares	Mean square	Variance ratio, F
Treatment	2	1536.17	768.085	4.027
Error	9	1716.5	190.722	
Total	11	3252.67		



**Figure 1.** distribution of students who believe those in in the interior receive little or no proper orientation.



**Figure 2.** Distrubiton of students who think school location had an influence on level of orientation and sensitization.

## 6. Discussion and implications

The research findings underscore the crucial role of orientation and sensitisation in shaping students' career aspirations and choices. The absence of significant differences among respondents from different universities suggests a need for a comprehensive approach to improving orientation across all institutions. The considerable number of students who believe they could have chosen better with proper orientation highlights the potential positive impact of enhancing orientation processes.

The influence of location on orientation and sensitisation is a noteworthy aspect of the study. While a substantial number of respondents perceived this connection, the diverse responses suggest that factors beyond location also contribute to students' perceptions of orientation quality.

The suggestions provided by respondents for enhancing orientation strategies offer valuable insights. The emphasis on expert involvement, both from within universities and through collaborative outreach efforts, showcases a consensus on the need for multi-stakeholder engagement. Additionally, the idea of utilising digital platforms for information dissemination acknowledges the changing technological landscape and the potential for a wider reach.

The concerning perception that students in rural areas receive inadequate orientation reflects the need for targeted interventions to bridge this gap. Ensuring equitable access to proper orientation is essential for empowering students from all regions to make well-informed career decisions.

Furthermore, the analysis revealed that there were no notable distinctions in the responses provided by the three groups of respondents (with a calculated F value of 4.027 compared to the tabulated F value at a 95% confidence interval of 4.256). Consequently, the implications suggest a shared imperative for students to enhance their orientation and sensitisation programmes prior to student registration.

## **7. Limitations**

While the study presents valuable insights into the influence of orientation and sensitisation programmes on Cameroonian university students' career decisions, it has certain limitations. The focus on specific universities restricts generalisability. The reliance on questionnaires for data collection overlooks other valuable approaches. Potential researcher bias due to involvement in data collection raises concerns. A cross-sectional design prevents establishing causal relationships. The study could benefit from exploring barriers to effective guidance and the long-term effects of orientation. Additionally, the theoretical framework's application and Likert-scale responses oversimplify the complex factors shaping career decisions and nuanced viewpoints. The ANOVA analysis, while informative, does not establish causation between treatment categories and outcomes. The absence of in-depth qualitative analysis limits a deeper understanding of open-ended responses. Finally, the study's geographical focus on Cameroon limits its applicability to broader contexts.

## **8. Conclusion**

This study highlights the importance of orientation and sensitisation in influencing students' career choices and aspirations. The findings underscore the need for universities to enhance their orientation processes to ensure that students receive comprehensive and relevant information before making crucial career decisions. The suggestions provided by respondents offer practical insights into the potential strategies that could be adopted to improve orientation quality.

Moreover, the study draws attention to the influence of location on students' orientation experiences, emphasising the need for nuanced approaches that consider both students' perceptions and the actual impact of location. The findings also shed light on the perceived disparities in orientation quality between urban and rural areas, urging policymakers and educational institutions to address these disparities to ensure equitable opportunities for all students.

This research serves as a foundation for future endeavours aimed at refining orientation processes in Cameroonian universities and beyond, ultimately empowering students to make well-informed career choices that align with their passions and aspirations.

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## Disclosure statement

There are no competing interests to declare.

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## WHAT MODERN GENERATION Z REALLY IS LIKE – STOCK MARKET INVESTMENT STRATEGIES AND ESG

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**Purpose:** The purpose of this paper was to investigate how important ESG is as a factor influencing Generation Z's investment strategies.

**Design/methodology/approach:** In order to achieve these authors decided to conduct a 10-week long experiment and collect the data both qualitative and quantitative. The data was gathered via an online questionnaire and during the classes with students participating in the experiment.

**Findings:** The main finding of the research is that the majority of the students did not consider ESG factors in their decision-making process. In spite of the visible knowledge on and awareness of that matter, almost none of the experiments' participants admitted to taking ESG into account during the development of their investment strategies.

**Research limitations/implications:** Main limitation of the research is the context of the experiments – they were organized during classes which could have impacted obtained results. In order to mitigate this factor a new group of students will be investigated in a different environment in the following months.

**Practical implications:** Possible practical implication of the research is lowering of the pressure for the companies to align with ESG regulations and legal ramifications when they want to attract new investors from the youngest generation.

**Social implications:** Social ramification of the findings is not to be neglected; if Generation Z is not as keen to lean onto ESG while making financial decisions as suspected, a possible shift in perceiving these issues by the mass audience is to be expected in the years to come.

**Originality/value:** The main value of this paper is possible contradicting of a well-known truth about Generation Z that they are the most environmentally savvy and conscious of all generations. It is entirely possible that ESG is just a phenomenon essential for only a marginal group of customers and majority of investors making their investment decisions disregard this issue entirely.

The main goal of the paper is to examine stock market investment strategies of Generation Z representatives who have a certain background in the field of finance. The study was conducted on a group of Polish students of the Faculty of Management of the University of Warsaw. Participants were asked to invest in the stock market using the GWP Tr@der investment platform in real time and over a period of eight weeks. Two research methods were applied: (1) a qualitative study of the participants' investment portfolio strategies, and (2) a survey containing quantitative and qualitative questions. The study sample included, respectively,

(1) 626 and (2) 314 students. It has been concluded that, when devising their investment strategies, representatives of Generation Z rely primarily on their knowledge and on current market information. Although some of them take ESG factors into account in their strategies, it cannot be considered a strong trend. New insights on ESG factors in investment strategies pursued by Generation Z are the paper's contribution to literature. The main limitation of the study is its scope in terms of the sample of study participants.

**Keywords:** ESG, gen Z, capital market, stock exchange games, investment strategies.

**Category of the paper:** Research Paper.

## 1. Introduction

Given price volatility in global financial markets, the growing complexity of financial products, rapidly developing financial innovations, and unlimited access to various sources of information, solid financial knowledge has become an essential tool for investors. Given the importance placed on pursuing the UN Sustainable Development Goals (United Nations, 2015), as well as the impact of ESG (Environmental, Social and Governance) factors on corporate performance and value, the latter may have an impact on the long-term performance of issuers of financial instruments. These matters must be duly taken into account in both the decision-making process (Boffo & Patalano, 2020), and the development of investment strategies.

Over the past decade, ESG factors have been increasingly reckoned with in investments; the value of professionally managed portfolios developed with key ESG ratings in mind exceeds USD 17.5 trillion globally (Boffo, Patalano, 2020), which seems to have proven the significance of ESG for investors.

The main players (individual investors) on the capital market represent – primarily – the following four generations:

- 1) Baby Boomer generation, born between 1945 and 1965; characterized mainly by their workaholic tendencies;
- 2) Generation X, born between 1965 and 1979; comfortable with authority and considering work-life balance as important;
- 3) Generation Y, born between 1980 and 1995; in general, its representatives grew up in prosperity and are tech-savvy;
- 4) Generation Z, born after 1995; grew up surrounded by technology, with constant access to the internet throughout their lives (Cilliers, 2017; Dolot, 2018).

The focus of our study is Generation Z, i.e. individuals born between 1995 and 2010. They are often referred to as digital natives, as a world without the internet, mobility, apps and social networks is not something they have ever experienced (Versace, Absy, 2022). According to Cazenove Capital, BofAML Generation Z (1995-2016) accounts for as much as 32% of the world population. It is worth noting that nearly half of the representatives of this

generation have already reached the age of majority. A search for scientific publications on Generation Z and the capital market within the Scopus scientific search engine ("generation Z + capital market") yields a rather meagre result: a total of ten articles, among which only two explore investments in the capital market. A study published by the World Economic Forum presents the choices of individual investors representing different generations if they were to invest USD 100,000. As many as 81% of Generation Z respondents chose to invest in the stock market. Among older respondents, only 49% opted for investing in the stock market (Armstrong, 2022).

The main goal of the paper is to examine investment strategies of Generation Z representatives in Poland. Respondents were second-year students of a master's program in Finance and Accounting at the Faculty of Management, University of Warsaw, and therefore had a certain level of professional knowledge of financial markets. They were asked to actively invest virtual funds on the local (Polish) stock market for a period of at least 7 weeks during the academic year.

## **2. Literature review**

### **2.1. Stock market investment strategies**

The definition of the financial market is broad and comprises entities (participants), objects (instruments) and the entire infrastructure – rather extensive in the modern economy. In an attempt to ensure its efficient operation, a number of legal acts have been adopted over the years, in particular in the wake of the subsequent crises. A well-functioning financial market should be effective (from the point of view of capital allocation) and flexible (i.e. able to quickly adapt to market changes); furthermore, its institutions should be solid and stable.

According to the efficient market hypothesis, also known as the efficient market theory, published in 1970 by Fama, stock prices reflect all available information. In other words, stocks and shares are always traded at their fair value, making it impossible for investors to purchase undervalued stocks or to sell stocks for inflated prices. Therefore, it should be impossible to outperform the overall market through expert stock selection or market timing, and the only way an investor can obtain higher returns is by purchasing riskier investments (Fama, 1970).

Individuals investing in financial markets forego current consumption in favor of future, yet uncertain profits. Professional investors adopt investment strategies that enable them to take a consistent and methodical approach to investing any surplus resources in financial instruments selected on the basis of the assumptions they have made. The choice of investment strategies is contingent on a number of factors, both dependent and independent of the investor.

1. Expected rate of return on investment.
2. One's risk tolerance, i.e. the level of risk that the investor is willing to accept, and the process of building an investment portfolio based on it. In the expected utility theory, three types of trends are identified based on the degree of risk tolerance of investors:
  - a. risk aversion,
  - b. risk loving,
  - c. risk neutrality (Samimi, Samimi, 2020; Satti et al., 2013).
3. The investment style that is the consequence of the expected rate of return and of one's approach to risk:
  - a. aggressive portfolio (high risk, high potential rate of return),
  - b. balanced (neutral) portfolio (medium risk, medium potential rate of return),
  - c. conservative portfolio (low level of risk, low potential rate of return).
4. Investment time horizon. When building an investment strategy, one needs to consider the time period during which (s)he is willing to hold the investment (investment portfolio). Geoff Warren identifies a total of 12 factors that affect investment horizon decisions. They are divided into 4 groups:
  - a. related to investor circumstances (e.g. nature of funding or liabilities, tolerance for illiquidity),
  - b. related to the investment environment (e.g. financial market structure, organizational structure),
  - c. related to investor's choice (e.g. investment process and philosophy),
  - d. other (culture, limits to arbitrage) (Warren, 2014).
5. Investors' economic situation affects their approach to risk. Key aspects include:
  - a. access to emergency funds. The quantity of assets allocated to investments vs. the quantity of assets that provide the investor with a sense security,
  - b. change in the investor's income level,
  - c. the share of debt in the investor's assets (Fidelity Investments, 2022).
6. Investors' knowledge and access to information:
  - a. Knowledge undoubtedly helps build appropriate strategies tailored to the needs of a specific investor (economic knowledge, i.e. understanding issues related to the environment; financial knowledge that allows one to analyze potential investments and understand behavioral finance). Another aspect is knowledge application (tool-based knowledge: how and where transactions should be made, how to adopt and use modern technologies), and therefore the investor's increased self-confidence resulting from his/her knowledge, which subsequently translates into effective investments (Forbes, Kara, 2010; Hidayat et al., 2020).



- b. A number of researchers claim that information from the capital market may affect or, conversely, have no impact on investment decisions whatsoever. In 1974, Taylor presented a risk-taking model comprising three phases. The first phase includes individual assessment of psychosomatic factors. The second phase involves the development of risk mitigation strategies, in which individuals assess potential financial losses and emphasize the importance of acquiring and managing information. The final phase determines the investment decision (Taylor, 1974). For Taylor, searching for information was important and formed the basis for the investment decision; in contrast, according to Fama's efficient market hypothesis, if the market is efficient, none of this will matter (Fama, 1970). Even if information is confidential, it will prove irrelevant. Fama assumes that if one investor has had access to a given piece information, probably so have others. In his 1981 study, Stiglitz argues that although a pure exchange stock market is not a pure gambling market, most of the trade on the stock market arises from irrationality on the part of some investors and the rational response on the part of other investors to take advantage of that irrationality. This shows that the private returns to information acquisition and dissemination differ markedly from social returns and as a result the market equilibrium is not a (constrained) Pareto optimum (Stiglitz, 1981).
- 7. The macroeconomic situation and market environment directly affect financial markets, so information and knowledge have an impact on the process of building an investment strategy. Key aspects that investors should take into account include:
  - a. geopolitical situation,
  - b. macroeconomic situation,
  - c. capital market situation,
  - d. capital market development and access to it.

The factors discussed above form the basis for the selection and development of an appropriate investment strategy by specific investors, and for the construction of an optimum investment portfolio. When building a portfolio, investors need to take a number of decisions in order to create a portfolio that is consistent with their personal predispositions which, in turn, are determined by the factors listed above.

## **2.2. Generations and investment**

Pursuant to the generational cohort theory, generations are social groups that share a common birth period (Schewe, Noble, 2000). Generations are perceived as temporal phenomena; each generation grows up over a particular period during which personalities of individuals are shaped within specific technological, social and economic conditions. In order to belong to a given generation, individuals must be born and live within a specific time frame (Ryder, 1985). The division into generations results in unique investment patterns and behaviors, and investment choices made by individuals may be determined by the period in

which they were born. The impact of one's belonging to a specific generations on his/her unique investment patterns has yet to be extensively researched (Altaf, Jan, 2023). In the area of behavioral finance, investment behavior has been explored from the ethnic (Dickason, Ferreira, 2018) or national (Brosdahl, Carpenter, 2011) perspective, while studies of generational cohorts in this context are few and far between (Altaf, Jan, 2023).

This, in turn, implies that environmental considerations are of a certain importance for this age group. Based on this assumption (see also Tyson et al., 2021), it has been argued that while choosing and determining their investment strategies, GenZ is prone to selecting companies whose actions align with widely defined ESG values and principles of sustainable management. In order to operationalize this topic, the answers of the research group were gathered in rough categories and subcategories:

- ESG and sustainable development:
  - "are of importance to me",
  - "do not matter when I invest",
  - "depend on the industry".
- Origins of the company:
  - Polish,
  - international,
  - irrelevant.
- Ethics in operations:
  - "The company's activity must be consistent with my values",
  - "Companies need to consider the societal impact of their activities".

Since the answers were descriptive in nature, a qualitative approach was adopted; it yielded a number of astonishing results.

### **2.3. Stock market investment strategies**

In 2017, over 25% of managed assets worldwide were invested in line with the assumption that ESG factors may have a significant impact on the company's results and its market value (Bernow et al., 2017). In 2020, the amount of professionally managed portfolios that have integrated key elements of ESG assessments exceeds USD 17.5 trillion globally. A study by Bloomberg (2021) presents a trend that is bound to continue, forecasting this figure to rise to over USD 53 trillion by 2025 (Bloomberg, 2021).

In 2021, Oxford Risk, together with Standard Chartered, surveyed over 2000 investors; they argue that retail investors are highly interested in sustainable investments. The majority of respondents (81%) claimed to be interested in this concept, while 23% of investors declared being "very interested" in this topic (sample of 2040 investors) compared to 16% (sample of 1085 investors) a year earlier (Standard Chartered & Oxford Risk, 2021).

Climate change seems to be of paramount importance to Generation Y (Millennials) and Generation Z. Statistics show that when choosing investment products, as many as 33% of Generation Y take into account ESG factors often or exclusively. In the case of Generation Z, it is 19%, Generation X 16%, but Baby Boomers only 2% (Tyson et al., 2021). Generation Z and Y now account for 49% of the world's population. These two groups account for the largest percentage of the labor force; in addition, they may become beneficiaries of the transfer of wealth from older generations (Versace, Abssy, 2022). While the average investor in their 20s and 30s is willing to lose 6-10% of their investments if they know that the companies, they invest in are improving their environmental practices, the average Baby Boomer investor is not willing to lose any of their invested funds on account of it (Gelfand, 2022). The attitudes, values, beliefs and risk tolerance of Generation Z will inevitably shape their investment strategies (Versace, Abssy, 2022).

Based on the literature review, a research gap was identified in the analysis of investment strategies employed by the young generation. It shall be explored in more detail further in the paper; we shall focus on analyzing Generation Z as the world's largest population with, paradoxically, the least abundant body of research. The analysis shall address Poland and the Polish stock market.

In his 2021 work, Thomala confirmed that the subject of Generation Z and investment behavior had not been thoroughly researched (Thomala, 2021). The impact of one's belonging to a specific generations on his/her unique investment patterns has yet to be extensively researched (Altaf, Jan, 2023), and to the best of the authors' knowledge, the influence of ESG factors on investment decisions made by representatives of different generation have not been explored to date. In view of this research gap, investment strategies of young generations shall be analyzed.

### **3. Database and the research method**

The main aim of the article is to analyze the described investment strategies in terms of ESG factors among finance students who were to invest on the virtual Polish stock exchange using applications. The analysis focuses on the factors influencing the decision-making process of the young generation with respect to investments in the stock market, and on the importance they place on ESG aspects. While reviewing the existing literature, we did not come across any similar studies and, in our opinion, such insights are of utmost importance for implementing appropriate financial education strategies in financial market institutions. The following research questions have been formulated:

- 1) How did respondents take ESG issues into account when making investment decisions?
- 2) Did ethical and moral issues affect the choice of investment strategies?
- 3) How important was the company's country of origin for investors?

The study was conducted on a group of students of the Faculty of Management of the University of Warsaw; respondents were students of the second-year master's degree program in Financial Management and Accounting. A total of 626 students participated in the study (218 in 2022 and 408 in 2023). Each respondent was to devise an investment strategy and make assumptions regarding a portfolio of PLN 10.000. Based on this, participants invested virtually in real time over a period of seven weeks on an educational platform called GPWtrader run by the Warsaw Stock Exchange Foundation. Over this period, the study participants participated in a total of seven meetings (one per week) during which they presented their strategies, investment results, market observations and future goals.

The study was conducted in the summer semesters of academic years 2021/2022 and 2022/2023. Each year had its own challenges: macroeconomic (high level of inflation and the increase of interest rates by the Central Banks), geopolitical (war in Ukraine), and financial (2023 global banking crisis). Researchers organized their work with students in a similar manner during both semesters (in 2021/22 and 2022/23):

- 1) Organizational meeting was held during which the assumptions of the investment were explained and the platform was presented ( $T1 = t$ ).
- 2) Students submitted an investment strategy for their investment portfolio ( $T2 = t+3$ ).
- 3) Respondents started investing on the GPWtr@der platform (the day after they submitted the strategy) ( $T3 = t+4$ ).
- 4) Over a period of 7 weeks, weekly classes were held to allow students to discuss their strategies, investment results obtained, the current market information and their future investment plans (each study participant shared the outcomes of their investment decisions twice).
- 5) After 8 weeks, students summarized the results of their investments on the GPWtr@der platform during a meeting ( $T4 = t+56$ ).

During the simulation game, a survey that included quantitative and qualitative questions was conducted among the participants. Quantitative questions served to measure the effectiveness of the investment strategies chosen by students, to verify the assumptions they made, and to identify individual respondents. Qualitative questions required participants to provide descriptive answers regarding the following aspects:

- Reasons for choosing a strategy.
- External and internal determinants affecting the implementation of the strategy.
- Investment goals.
- Means employed to attain goals.
- Flexibility of the chosen strategy.

Quantitative research was conducted using an online questionnaire on the Google Forms platform. Study participants completed the survey during the last meeting (in 2021/22, N = 106, and in 2022/23, N = 208). In the study sample, women represented 70.1% (N = 220), and men 28.7% (N = 90); 1.3% of the sample did not declare their gender (N = 4). Table 1 below describes the structure of the questionnaire along with the questions and the measurement method.

**Table 1.**

*Structure of the questionnaire: Variables describing the course of stock market investments by representatives of Generation Z (students of Finance and Accounting)*

Question category	Question	Order of questions in the questionnaire	Measurement method
Investment efficiency	Portfolio size	2.1	Open (in PLN)
	Rate of return from the portfolio	2.2	Open (in %)
Participant's investment strategy	Did you hold on to the strategy you initially adopted?	2.3	Closed
	- How many times did you change your strategy?	2.4.1*	Sub-question for those who answered "Yes" to 2.3
	- What was the reason for the change of strategy?	2.4.2**	
	Did you take into account ESG ratings of companies in your investment decisions?	2.5	Closed
Investor decisions	Were your investment decisions influenced by the current news regarding the market?	2.6	Closed
	Were your investment decisions influenced by the decisions of other students?	2.7	Closed
	When making investment decisions, did you take into account information about the war in Ukraine?	2.8	Closed

\*closed, single-choice (disjunctive), \*\*semi-open (semi-closed) single-choice questions.

Source: own study.

Based on the previously described categories, we have made the following observations (all answers have been translated from Polish).

## 4. Results

The results of the quantitative survey, conducted at the end of the investment period, showed that nearly 18% of respondents confirmed that ESG was an important aspect affecting their choices, 10.5% were not aware of ESG information, and as many as 71.5% said that it was irrelevant to them. In the qualitative study, where the strategies developed by the respondents were analyzed, it was found that only 22 out of 626 respondents (which is a relatively low number) pointed to ESG in their answers. In the majority of responses, ESG is only named as a factor, without any further explanation or details ("I'll take ESG ratings into account", "I do take ESG into account as it's a worldwide trend", "I consider ESG ratings helpful",

"I intend to take suggestions from ESG ratings", "Most of my capital goes into WIG-ESG companies", "10% of my portfolio goes into ESG-compliant companies"), or respondents claim that ESG is useful as a risk-reduction tool ("Using ESG Risk Rating [...], I prefer low- to mid-level of risk", "High-tech industry [...], as they show low levels of ESG risk", "Safe investment based on low ESG Risk Rating"). One person pointed out that given her/his high-risk preference, (s)he would invest in companies with a high ESG Risk Rating, as only such entities offer a high return rate.

Some students elaborated more on the topic and most of the answers pointed to ESG as a helpful tool for carrying out a negative selection ("I exclude mining industry, especially coal companies, because they have a low ESG ranking and are not recommended as a good investment", "I prefer companies that do ESG reporting", "[Companies] that consider green assets are lower-risk [...] and have better access to financial markets in the future [...]").

Worth noting is the fact that only two students explicitly disregarded ESG as a factor influencing investments ("ESG issues will not play a crucial role in my choice of companies", "Given the volatile geopolitical situation and short-term investment, I will not take into consideration the ESG Risk Rating"), which might suggest that even though ESG is not a well-known concept among respondents, there is an underlying need to "do the right thing" when it comes to making investment decisions.

High-tech (perceived as green) and mining (perceived as the opposite) were the industries mentioned most often. Apart from these two, ESG seems not to affect the analysis of industries that deserve – or not – being invested in.

A number of answers covered a cross-section of ESG and ethical issues ("I'll take into account the ESG rating [...]. All these factors need to be considered in order to avoid investing in a company that does harm to the world", "Noticing ESG to saddle environmentally-friendly businesses", "ESG-respecting [companies] are transparent in their communication with markets and do not decide in their financial reporting").

However, such answers were few and far between and no explicit interest for ethical aspects of the investment process was observed among the students, with only two (!) exceptions: "I do not invest in companies whose actions clash with my ethical and moral values", and "In my portfolio, I only include companies that respect the law [...]; immoral behavior will make me exclude a company from my investment choices"). More common was an implicit assumption that companies should align with a certain set of values in order to be eligible for investment ("I'll take guidance from ESG ratings, being in line with the green finance trend").

On the other hand, as many as 84 respondents were interested in investing in Polish companies. Some students chose a specific company (Polska Miedź, Komputronik, CD Projekt etc.), while others only pointed to this factor as affecting their investment decisions, which suggests that – contrary to what one might expect – for Gen Z, "patriotism" takes precedence over "ethics".

One of the main research findings is that – in spite of the popular belief prevalent in the media and in literature – Gen Z's investment strategies and decisions are not driven by ethical or environmental considerations, but are rather practical in nature. 'Return rate', 'risk level', 'portfolio diversification' etc. are factors identical to those that one might expect from research on Millennials, GenX-ers or Baby Boomers. On the one hand, it is perfectly valid and corroborates the concept of the rational decision making process that spans generations and is typical of investors in general. On the other hand, however, one might find this slightly incoherent, if we consider Gen Z's support for the ideas of sustainable living advocated by a number of young activists from their generation.

One possible explanation is that our study was based on declarations and did not measure real-life investment decisions of respondents. Thus, we may assume the existence of a discrepancy between declarations and actual actions, choices and attitudes. The downside of this presumption is that in most cases, people act LESS noble and moral than they claim to do; in this case, the exact opposite was observed. Another reason might be the context in which the study was carried out: students are used to being watched and evaluated and, knowing that the investment process was only an exercise revolving around a game, they disregarded ethics and real-life consequences of their choices, focusing instead solely on financial results. This, in turn, might explain their declarations and disregard for the moral aspects of the process. Given the nature of the experiment, this seems to be the most likely reason behind the phenomenon.

## 5. Discussion

The main limitations of the study are its scope, as it was limited to students of the Faculty of Management of the University of Warsaw, and the size of the sample. It should be emphasized that the research should be regarded as a preliminary study whose aim is to provide general information about the research group and their decisions regarding investments in the capital market.

An in-depth analysis of the process of devising stock market investment strategies by Generation Z indicates that this age group relies on their knowledge (i.e., the understanding of the matter by students in the final year of Accounting and Finance). Knowledge obviously helps build appropriate strategies tailored to the needs of specific investors. The latter's greater self-confidence resulting from their solid knowledge is conducive to effective investments (Forbes, Kara, 2010; Hidayat et al., 2020). Over 71% of participants declared that they held on to their initially adopted strategy, while others modified it. Participants who did adjust their strategy were asked about the reasons for doing so, and nearly 37% of the entire surveyed group stated that they had modified their strategy on the basis of the additional knowledge gained through their participation in the stock exchange simulation game. It allowed some of them to

understand the market better, and it also resulted in a higher average rate of return on the investment portfolios held by this group. The average rate of return on the virtual portfolios of all study participants ( $N = 314$ ) was 5.30 %. Students who kept up to date with the current market information (88.5% of participants) also achieved better results than those who were not aware of it (7.5%) or did not take it into account (4%). Interestingly, almost 40% of the entire surveyed group declared that their decisions were influenced by the choices of other study participants, and they achieved significantly higher rates of return on their portfolios than those who either did not take this information into account, or did not have it. Participants were also asked about the impact of the war in Ukraine on their decisions and, once again, it was confirmed that those study participants who were aware of the current situation and took it into account attained significantly higher rates of return than those who did not know it or did not take it into account. The analysis of the results confirms that knowledge (Stiglitz, 1981; Taylor, 1974) and current information that may affect the listed companies are important factors influencing the process of creating and implementing a strategy (Forbes, Kara, 2010; Hidayat et al., 2020).

ESG factors may have a significant impact on the company's results and its market value (Bernow et al., 2017). Research conducted by Standard Chartered and Oxford Risk confirm that individual investors are highly interested in sustainable investments (Standard Chartered & Oxford Risk, 2021); although the participants of our study were inquisitive about the matter, it did not determine their main assumptions regarding potential investment activities. Even if they took into account sustainable development factors in their strategies, these did not dictate their decisions.

## 6. Conclusion

Within financial markets different groups of investors can be identified; their financial behavior is characterized by specific features that they share (Altaf, Jan, 2023; Kalra Sahi, Pratap Arora, 2012; Pantano, Stylos, 2020). An analysis of subsequent generations demonstrates specific investment patterns and behaviors (Altaf, Jan, 2023). The aim of this study was to examine stock market investment strategies adopted by Generation Z with regard to ESG factors. A broad and detailed qualitative analysis of strategies, together with a survey carried out among the participants of the experiment has allowed us to draw several conclusions. Firstly, when developing their investment strategies, representatives of Generation Z rely mainly on their knowledge of finance and current information from the market. Secondly, ESG factors do appear in their strategies, but this trend cannot be considered as strong. This seems to find confirmation in the post-survey questionnaire, according to which only 18% of participants took ESG ratings into account in their investment strategies. And, finally,



Generation Z, just as Generation Y (Millennials), are willing to invest in companies that are socially responsible (Altaf, Jan, 2023).

Based on these findings and given a research gap in this area, the authors intend to continue the systematically conducted experiment with representatives of Generation Z who will invest virtual funds in a stock market simulation game. The group of participants shall be expanded to include younger representatives of Generation Z, as well as participants from other universities. Further research will cover the analysis of the strategy and the results taking into account the personality of individual participants, strategies developed by them and results yielded by investment portfolios.

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## IDENTIFYING CYBERRISK FACTORS IN HYBRID WORKFORCE ENVIRONMENTS

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**Purpose:** This academic paper addresses the impact of cyberattacks on companies, employees, and customers, particularly in the context of increased digitalization due to the pandemic. It emphasizes the importance of the human factor in cybersecurity and proposes the need for a universal tool to measure threat perception and behaviour tendencies. The paper aims to expand knowledge in measuring employee exposure to cyberthreats, especially in remote and hybrid work, by presenting methodology, findings and applications.

**Research Background:** In recent years, cybersecurity has gained significant attention, with a surge in published articles focusing on technical aspects and the human factor. However, there is a research gap regarding potentially dangerous behaviour among employees in remote or hybrid work models. Understanding individual differences in perceptions of cybersecurity is crucial for identifying vulnerabilities and enhancing corporate cyber resilience.

**Methods:** A qualitative pilot study was conducted to create the "Employees' Exposure to Cyberthreats Scale" based on interviews with cybersecurity professionals. The scale was then validated through a survey study with a representative sample of remote employees (N = 563). The questionnaire employed an expectancy approach, assessing severity and probability of unsafe behaviours on a 5-point scale.

**Findings & Value Added:** This paper presents the development and validation of a cyber exposure scale, measuring general and specific categories of cyberexposure. Three behaviour categories emerged: environmental, credential-related, and behavioural. The study provides preliminary results and practical implications for organizations to enhance cyber resilience, emphasizing the importance of employee behaviour and attitudes for cybersecurity practices. The findings contribute to tailored security policies and the development of a cybersecurity-focused organizational culture.

**Originality/value:** This research addresses a gap in the current cybersecurity literature by focusing on the behaviors and perceptions of employees in remote and hybrid work models, an area which has seen increased relevance due to the pandemic-induced shift to digital platforms. Introducing the 'Employee Cyber Threat Exposure Scale', this paper provides a tool to measure individual differences, offering organisations insights to strengthen their cyber resilience.

**Keywords:** cybersecurity; cyber resilience; remote work; cyber behaviours; digital transformation.

**Category of the paper:** Research paper.

## 1. Introduction

The number of cyberattacks increases every year, and the phenomenon has only intensified due to the pandemic and the shift of most users to the virtual channel. According to McKinsey (2022), the pandemic has accelerated the average share of fully digitalized products and services by seven years globally and in the case of customer interactions by three years. This means that growing numbers of companies, their employees, as well as users and customers, are operating in the digital channel, implying that the attack surface has increased. This is visible in the number of recorded hacking attacks and data leaks that are regularly reported by the global media.

The organisation of companies' vulnerability to cybercrime and the prevention of attacks has increasingly focused on the human factor. A significant amount of the academic literature related to information security has shifted its focus from the technological aspect to considering the role of employee attitudes and behaviours. Researchers dealing with the relationship between humans and cybersecurity noted a general discrepancy between actual behaviour and awareness or knowledge of rules, although no separate research was devoted to this issue (Bada, Sasse, Nurse, 2019; Hong, 2023; Pratama, Alshaikh, Alharbi, 2023; Zwilling et al., 2022). There is a paucity of literature on the subject of worker exposure to cyberthreats. Additionally, most studies use separate scales for measuring behaviour and attitudes, while in our study we suggest a synergy of both approaches and the creation of a universal tool for analysing the perception of threats, tendencies toward specific behaviours and the aggregation of both of the above values. In addition, the context appears to be important, which at the same time affects the novelty of the proposed project: it is highly embedded in reality, which is influenced by the COVID-19 pandemic and the related changes in the way work is performed, the use of devices, and the company's IT facilities, as well as the accelerated digital transformation of many organizations. The conducted research is motivated by the inability to provide security by using only technological solutions that fail if employees do not comply with cybersecurity rules, are against them, or even display risky behaviour (Anwar, He, Yuan, 2016; Hadlington, 2017; Bada, Nurse, 2019; Moustafa, Bello, Maurushat, 2021). The present study considers the relationships between the attitudes of employees towards problematic and thus potentially unsafe use of the Internet and devices, as well as their ability to engage in behaviours related to the security level of the corporate network and data (Alahmari, Duncan, 2020). The goal is to expand our knowledge of measurement tools for employees' exposure to cyberthreats.

The Risky Cybersecurity Behaviour Scale (RScB) (Egelman, Peer, 2015) and Attitudes Towards Cybersecurity and Cybercrime in Business (ATC-IB) (according to Hadlington, 2017) were developed in 2015 and 2016, respectively, taking into account the then-current conditions. The RScB Scale analyzed the specific types of "risky" cybersecurity practices users were involved, while another the ATC-IB Scale outlook on cybersecurity and their overall understanding of cybercrime. A novelty and contribution to the existing body of literature in our paper is the development of a measurement tool in line with the new cyberspace uses evolved after 2015 and 2016, and the evolution of technology. Our proposed scale is partially based on the previously developed tool (Egelman, Peer, 2015), and was created with input from digital forensic investigators and law enforcement. It includes behaviours that lead to poor cybersecurity practises that have caused companies to be attacked. The ATC-IB scale (according to Hadlington, 2017) was constructed based on expertise from the police, digital forensics, criminal psychology, and cyber psychology, to reflect a wide range of attitudes towards both cybersecurity and cybercrime within a business context. The present research verified the items contained in both measurement tools and adjusted them to the reality of changes in the rules of work (remote/hybrid) in connection with the COVID-19 pandemic. Remote working and intensifying social engineering attacks appear to be particularly important. The main aim of the research undertaken was to fill the research gap by:

- identifying and categorising items related to risky Internet and device use,
- expansion of the scale of hybrid and remote employees' exposure to cyberthreats.

The structure of this paper is as follows: firstly, it introduces the scope of research conducted so far, which takes into account the aspects of cybersecurity and the human factor, with particular emphasis on the tendency to engage in potentially risky behaviours. The methodology and methods of data analysis are then described. This is followed by a discussion of the research findings, their interpretation, and areas of application. Finally, the limitations and conclusions of this research are presented.

## 2. Literature review

The subject of cybersecurity is becoming a topic of interest for researchers, academics, and representatives of the business world. It should be emphasised that this is not a new phenomenon. In the Web of Science database, 12,164 articles containing the term 'cybersecurity' have appeared since 2010. The majority of them were published after 2017, while the limiting date after which more than 10 articles per year started to be published is precisely 2010. After applying publication date and journal category restrictions, 2256 articles were further analysed, with 182 papers being reviewed in detail at the end (description in Appendix 1). The bibliometric analysis demonstrates that the body of research is expanding,

however the great majority of them focuses on the technical aspect. Nevertheless, there are studies and conceptual works dedicated to the human factor in cyber security. Interest in the topic of cyber security can start by defining cyberspace as an expanding network structure (Ergen, Ünal, Saygili, 2021). The challenge is to accurately define cyberspace due to its growing global reach and the possibility of merging or interpenetrating different spheres, making its boundaries unrecognisable (Lu, Ye, Tan, 2023; Singer, Friedman, 2014). Cyberspace will provide a platform where resources such as individuals' digital lives, data, equipment, national infrastructure, or national systems become accessible without the barriers of physical space, which means that they are vulnerable to cyber-attacks and need to be protected (von Solms, von Solms, 2018). Meanwhile, in a rapidly changing reality, the development of technology, digital products and services represents a social aspect linked to the actions of users and, in the case of companies, and employees, is becoming increasingly important. Everyone should be aware of the cybersecurity risks and be prepared that individual actions may increase the risk, whereas proactive activities such as awareness-raising may reduce it. Hence, there is a demand for a reliable and valid instrument to measure cybersecurity practices and their perceptions.

Researchers have attempted to investigate how individual differences may affect a person's compliance with cybersecurity procedures and the risk behaviours manifested by them. Shropshire et al. (2006) and Panko (2010) noted that inappropriate use of computers, including using unauthorised applications or downloading files from unknown sources and visiting infected websites, is part of the catalogue of bad cyber-security behaviours, but called for further research to identify which aspects are technology-related. McBride, Carter and Warkentin (2012) found that more extroverted individuals were more likely to have cyber security breaches than more neurotic and conscientious individuals. Uebelacker and Quiel (2014) investigated the relationship between vulnerability to social engineering attacks and personality. Shropshire, Warkentin and Sharma (2015) demonstrated that the intention to use the new security software and the actual use of it were also due to diligence and agreeableness. In addition, there are several studies which associate different demographic characteristics with distinctive behaviours in cyberspace. Some researchers point to age as an important factor. According to their findings, younger people in the 18-29 age group are less aware of and more susceptible to attacks using social engineering techniques such as, inter alia, phishing compared to those over 30 (Arend et al., 2020; McCormac et al., 2017; Sağlam, Miller, Franqueira, 2023). Another variable is gender, which is also, in some studies, linked to different levels of cyber vulnerability. In this case, women are less aware, especially when it comes to data leakage attacks. On the other hand, they are more likely to update their software regularly and follow the rules of company security policies (Anwar et al., 2017; Gratian et al., 2018; Ünal, 2020). There is also a wave of research focused on conscientiousness, agreeableness, and openness (McCormac et al., 2017), which combines the above features with reduced risk-taking and increased awareness of good cybersecurity practices. Attitudes towards risk-taking appear to be



related to different dimensions of cyber security, according to research already conducted. Risk-taking folds into less safe online behaviour, while attitudes related to risk avoidance in the physical world (e.g. a deficiency of interest in extreme stunts) demonstrate a negative correlation with proactive protective behaviour in the cyber world (Hadlington, 2018). Subsequently, researchers are keenly and frequently exploring topics related to trust, as well as the perceived risk and security of specific technologies, such as the Internet of Things, mobile banking, but also the wider use of apps in everyday life (Kumar, Yukita, 2021; Merhi et al., 2020; Monfared et al., 2023). In addition to individual perceptions of risk, attitudes towards decision-making still appear to be important, which, as the authors point out, requires in-depth research and is one of the reasons for addressing this topic in the following article (Donalds, Osei-Bryson, 2020). Within the academic discourse on the relevance of the human factor in cyber security, there is also a theme of not mistreating users as enemies. In the literature, the most commonly stated reasons are related to the role of users as the first line of defence against cyber threats (Abawajy, 2014). Most cyber-attacks rely on tricking users into taking some action, such as clicking a malicious link or opening a phishing email. Educating users on how to recognize and avoid these types of attacks is an important part of protecting the organization. Treating users as enemies can also create a negative culture (Enescu, 2019). If users feel that they are constantly being blamed for security breaches or that their actions are being heavily monitored, it can create a negative and unproductive working environment.

Simultaneously, with the growing interest in the human factor, there is a gap in the scale for measuring potentially dangerous behaviour among employees working from home or in the hybrid model, taking into account the changes that have occurred in the application of technology since the introduction of the Risky Cybersecurity Behaviour Scale (RScB; Egelman, Peer, 2015) and Attitudes Towards Cybersecurity and Cybercrime in Business (ATC-IB, according to Hadlington, 2017), which were developed in 2015 and 2016, respectively. Meanwhile, research confirms that better individual differences regarding perceptions of cyber security can guide researchers, organisations, and those responsible for corporate cyber resilience to better understand vulnerabilities to potential attacks (Gratian et al., 2018).

### **3. The research**

#### **3.1. Eliciting list of cyberthreats**

We conducted a qualitative pilot study to create the employees' exposure to cyberthreats scale, using the RScB and ATC-IB scales as the basis for the interview scenario. The study was conducted on a purposively selected sample of cybersecurity professionals (N = 11) and consisted of two stages: IDI and the selection of the final list of behaviours by competent judges.

A competent judge in scientific research methodology is an individual who is knowledgeable about the principles and practices of scientific research and is able to evaluate the quality and validity of research studies. It is generally expected that competent judges will have a good understanding of the relevant research methods and principles in their area of expertise (Wolfson, 1986). In the case of our study, they were people with more than 10 years of experience in the cybersecurity industry, involved in threat detection, identifying attack vectors, and designing appropriate security features to prevent them. In turn, the experts were people who had worked in the cyber security industry for less than five years and were involved in offering, implementing, and training company employees. Each of the experts and competent judges works for a different organization and, during the study, they did not communicate with each other regarding the judgements they made.

During the IDI, experts updated potentially dangerous behaviours, for example, by rejecting claims about downloading entertainment from the Internet, and adding behaviours as a result of remote working and the necessity of combining work and family responsibilities—such as lending work computers to children for online learning<sup>1</sup>. In total, the experts identified 57 potentially dangerous online behaviours, adequate for the digital transformation forced by the COVID-19 pandemic. Competent judges rated this list of behaviours on a 5-point Lickert scale, assigning a score of one to five, and shortened this list to the most dangerous. As a result, we received a 36-item scale of unsafe behaviour, which we used for quantitative research.

### 3.2. Construction of the scale

#### Overview

The preliminary list of 32 items from the pilot study was used to create a questionnaire based on the expectancy approach, which is widely used in motivation studies (Vroom, 1964) and attitude research (Fishbein, 1967; Ajzen, Fishbein, 1977; Ajzen, 2011). We contend that expectancy, defined as the composite of the subjective assessment of the severity of the threat (i.e., value) and the subjective assessment of the probability of a threatening behaviour being performed (i.e., probability), is the appropriate way to measure the risks associated with various employee actions.

The model applied to cyberthreats can be described by the following formula:

$$CE = ss_1 \times p_1 + \dots + ss_i \times p_i$$

where:

CE – Cyber exposure,

ss<sub>i</sub> – subjective assessment of the severity of the threat,

p<sub>i</sub> – subjective assessment of the probability of the threatening behaviour,

<sup>1</sup> The digital transformation caused by the COVID-19 pandemic was rapid and holistic—it concerned all aspects of life, including the need to bring education in schools online. There was a sudden shortage of computers on the market, and many families in Poland were forced to either (1) use private computers for business purposes or (2) lend computers to other household members.

## Method

The idea of the scale to the subject was based on Exploratory Factor Analysis (EFA) approach, hence no a priori hypotheses concerning the structure of the scale were put forth. The factorial structure was to be elicited on the basis of the results of the survey study in which the participants evaluated the severity of the threats posed by online behaviours.

The questionnaire consists of two sets of items: (a) measuring the valence – subjective evaluation of the severity of the behaviours and (b) measuring the subjectively assessed probability of performing the behaviours. The severity of the threat: i.e. how big the threat of the following behaviour is? was measured with a 5-point scale ranging from 1= no threat at all to 5= very big threat. The probability of a threatening behaviour i.e. how probable is it that you perform the following behaviour was measured with a 5-point scale ranging from 1= zero probability to 5= very high probability.

## The sample

The participants (N = 563) were a representative sample of employees who have experience working remotely, recruited from the biggest national internet research panel (Ariadna).

## Results

The assessment of the general level of cyberthreats exposure. The first step in the factor analysis was to develop a one-factor cyber exposure scale that would allow for the calculation and indexing of general levels of exposure to cyberthreat. To achieve this, the list of 32 items measuring the severity of the behaviours was subjected to principal component factor analysis with Varimax rotation<sup>2</sup>. For the factor loadings see Table 1.

**Table 1.**  
*The factor loadings*

	<b>General cyber- exposure</b>
Not using two-factor authentication for organization resources.	.816
Sending confidential data by e-mail without securing it with an additional password.	.813
Storing company information on personal electronic device (e.g. smartphone/tablet/laptop).	.812
Postpone updating any installed antivirus software.	.810
Downloading digital media (music, films, and games) from unlicensed sources.	.802
Downloading free software from an unknown source.	.802
Using free online file transfer service (e.g. WeTransfer).	.799
Not checking for updates of the used web browser.	.788
Downloading data and material from websites on work computer without checking its authenticity.	.777
Not locking the computer when leaving it. (e.g. no screensaver with a password).	.776
Postponing software updates on smartphone/tablet/laptop/computer.	.774
Disabling anti-virus software on work computer in order to be able to download information from websites.	.766
Using the same password for multiple websites.	.763
Having no antivirus program on the computer.	.762

<sup>2</sup> Varimax rotation is a typical factor analysis in psychology that allows the construction of a scale with orthogonal dimensions.

Cont. table 1.

Creating company documents in public places (e.g. when travelling by train or plane).	.761
Sharing a work computer or work phone with household members (e.g. using a work computer for online lessons).	.755
Conducting/participating in video conferences in public places.	.751
Using free-to-access public Wi-Fi.	.750
Using an unchanged (provided by the Internet provider) password on your home Wi-Fi.	.739
Using or creating passwords that are not very complicated. (e.g. family name and date of birth).	.733
Sending personal information to strangers over the Internet.	.733
Sharing current location on social media.	.729
Clicking on links contained in an email or social media message from a trusted friend or work colleague, even if they have strange content (e.g. "I'm in a contest, I need your vote").	.726
Using automatic password storage systems in your web browser.	.721
Using or creating passwords that do not include minimum standards (e.g. 8 characters minimum, upper- and lowercase characters, symbols).	.718
Create videoconferencing in free applications such as Zoom.	.709
Sharing your home Wi-Fi password with other people	.709
Relying on a trusted friend or colleague in terms of advice on aspects of online-security.	.698
Sharing password with trusted friends or colleagues.	.687
Clicking on links contained in unsolicited emails from an unknown source.	.686
Accepting friend requests on social media, after recognising the photo.	.670
Storing credit card numbers in shops that are rarely used.	.659

The scale is consistent, and all 32 items contribute to a single factor of general cyberexposure. One factor solution explains 56.4% of the variance and produces a highly reliable scale of Cronbach alpha = .97.

### **Results: The assessment scale of the specific levels of cyberthreat exposure**

Reconstructing the natural categories of cybersecurity-related behaviours was the purpose of this part of our research. Factor analysis is a popular method for eliciting mental or perceptual structures. We assumed that for practical purposes (i.e. diagnosis, prevention and employees' training) the company would request a way of grouping the behaviours into some categories based on the way they are perceived by the employees. This led us to explore a multi-factor solution that would allow us to separately assess the cyberexposure arising from different categories of behaviours.

The list of 32 items (again the severity ones) was subjected to factor analysis, principal components method with Varimax rotation. The items with factor loadings below .50 were eliminated. Both the Kaiser criterion and the scree plot test corroborate the three-factor solution (see Appendix 2). The authors decided to give the factors names related to the main feature manifested in them, i.e. environmental, behavioural and The analysis revealed three factors accountable for 67% of the variance explained. The authors decided to give the factors names related to the main feature manifested in them, i.e. environmental, behavioural and credential-related. See Table 2 for the matrix of 26 items with their factor loadings.

**Table 2.***The matrix of 26 rotated factors with their factor loadings*

	<b>Environmental</b>	<b>Behavioural</b>	<b>Credential-related</b>
Create videoconferencing in free applications such as Zoom.	.825		
Conducting/participating in videoconferences in public places.	.817		
Creating company documents in public places (e.g. when travelling by train or plane).	.763		
Sharing a work computer or work phone with household members (e.g. using a work computer for online lessons).	.733		
Using free-to-access public Wi-Fi.	.693		
Not using two-factor authentication for organization resources.	.683		
Sharing current location on social media.	.634		
Accepting friend requests on social media, after recognising the photo.	.633		
Not checking for updates of the used web browser.	.629		
Not locking the computer when leaving it. (e.g. no screensaver with a password, etc.).	.622		
Postponing software updates on smartphone/tablet/laptop/computer.	.599		
Giving home Wi-Fi password to other people.	.555		
Clicking on links contained in unsolicited emails from an unknown source.		.844	
Sending personal information to strangers over the Internet.		.802	
Downloading data and material from websites on work computer without checking its authenticity.		.790	
Having no antivirus program on the computer.		.773	
Clicking on links contained in an email or social media message from a trusted friend or work colleague, even if they have strange content (e.g. "I'm in a contest, I need your vote").		.762	
Disabling anti-virus software on work computer in order to be able to download information from websites.		.652	
Postpone updating any installed antivirus software.		.632	
Storing company information on personal electronic device (e.g. smartphone/tablet/laptop).		.577	
Using or creating passwords that are not very complicated. (e.g. family name and date of birth).			.821
Using or creating passwords that do not include minimum standards (e.g. 8 characters minimum, upper- and lowercase characters, symbols).			.797
Sharing password with trusted friends or colleagues.			.779
Using the same password for multiple websites.			.756
Using online storage systems to exchange and keep passwords.			.682
Using an unchanged (provided by the Internet provider) password on your home Wi-Fi.			.596

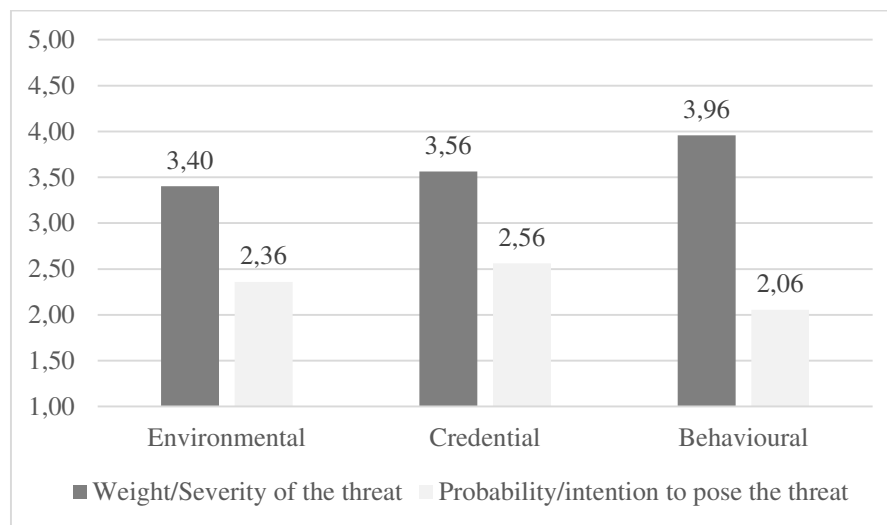
The factor grouping the behaviours related to working online in unsafe places (and creating such unsafe places) was named *environmental* threats; the factor grouping the various types of misuse of *credentials-related* threats, and the careless behaviours and omission of preventive actions we decided to call *behavioural* threats.

The three sub-scales are highly reliable: for the *environmental* scale, Cronbach's  $\alpha = .95$ , (2) for the *credentials*, Cronbach's  $\alpha = .9$ , and (3) for the *behavioural*, Cronbach's  $\alpha = .94$ .

### 3.3. Preliminary results of the application of the scale

The PMP's scale was distributed online (Ariadna panel) the representative sample of 563 employees with experience working remotely (the same sample as for the construction of the scale). To test the differences between three categories of threats (i.e. the *environmental*, the *credentials*, and the *behavioural*) repeated measures analysis of variance was conducted with the category of the threat as a within-subject variable, separately for severity and probability responses.

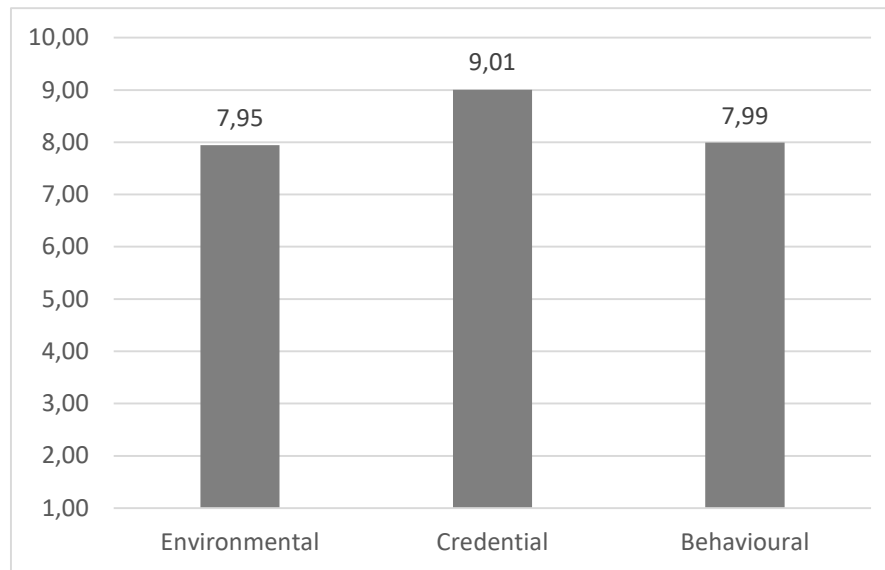
The analysis for severity revealed a statistically significant differences between various types of threats ( $F(2, 1124) = 191.21, p < .000; \eta^2 = .25$ ). The analysis for probability also revealed significant differences between the types of threats ( $F(2, 1124) = 194.09, p < .000; \eta^2 = .26$ ). The results are presented in Figure 1.



**Figure 1.** Mean severity and mean intentions to perform threat-posing actions.

According to Figure 1, threats related to the unprotected environment have the lowest severity, while behavioural threats (traditionally considered as such) have the highest severity (all differences significant at  $p < .001$ ). The pattern for probability is also consistent with the notion of 'traditional' threats – the willingness to do so is the lowest (all differences are significant at  $p < .001$ ).

The most useful in business practice is the analysis of the compound result—the risk posed by the employees to the company—calculated as an expected value. Repeated measures Anova revealed significant differences between the risk related to different types of behaviours elicited in our/PMP scale ( $F(2, 1124) = 64.12, p < .000; \eta^2 = .10$ ). The mean values are presented in Figure 2.



**Figure 2.** Mean values of risk posed by the employee's actions.

As can be seen, the highest value is 9.01, indicating the highest risk is associated with credential misuse, with the remaining factors a slightly lower. The results are interesting because the traditional risks (environmental and behavioural) appears to be quite well recognised and avoided, however the credential misuse has the highest anticipated value mostly due to the highest level of intention to perform such threat-posing actions (and omissions).

#### 4. Practical implications

One of the practical implications of our article is to identify the various determinants of cyber-risky behaviour that may be measured. Shedding more light on this aspect can contribute to the creation of more tailored security policies in organizations, which can increase the cyber resilience of companies.

In our study, we uncovered the *environmental*, *credentials* and *behavioural* threats for which it is possible to measure factors related to an organisation's cyber resilience. The scale makes it possible to perceive the extent to which employees' intentions in each of the identified categories can increase or decrease cyber security. Intentions are often considered to be strong predictors of behavior as they take into account an individual's attitudes and beliefs, and intentions reflect an individual's motivation to engage in a particular behavior.

Considering the practical implications, they contribute to building an organisational culture focused on a good, positive approach to cybersecurity, which may take time but will ultimately protect companies from online threats in the long run. Organizations can strive to make good habits second nature to their employees, which in turn will help prevent hackers from exploiting existing security environments more effectively. In particular, rather than focusing on malicious

attacks, security policies should recognise that many breaches by employees are the result of trying to balance security and productivity.

## 5. Conclusions

The scale used for the study was updated with the actual exposure of employees to cyberthreats, and the research itself was conducted during the digital transformation of companies forced by the COVID-19 pandemic. Most previous studies employed separate scales to measure behaviour and attitudes, while the present study suggests a synergy of both approaches and the creation of a universal tool for analysing threat perception, behavioural tendencies and the aggregation of both of the above. Furthermore, the proposed research is supported by its immersion in the current reality created by the COVID-19 pandemic and associated changes in distributed workplaces, as well as the accelerated digital transformation of many organizations. Studies 1-3 achieved two basic objectives: (1) validating the scale of dangerous behaviour; (2) identifying three types of risk factors.

The results presented are a step towards understanding the differences in the behaviour and attitudes of employees, especially those working remotely, that can determine good cybersecurity practices, and underline the demand to focus directly on more effective training and awareness-raising mechanisms, which will result in companies being more resistant to cyber threats. The appropriate adaptation of measures to increase cybersecurity in the company will allow (1) its more effective operation and (2) reduced costs.

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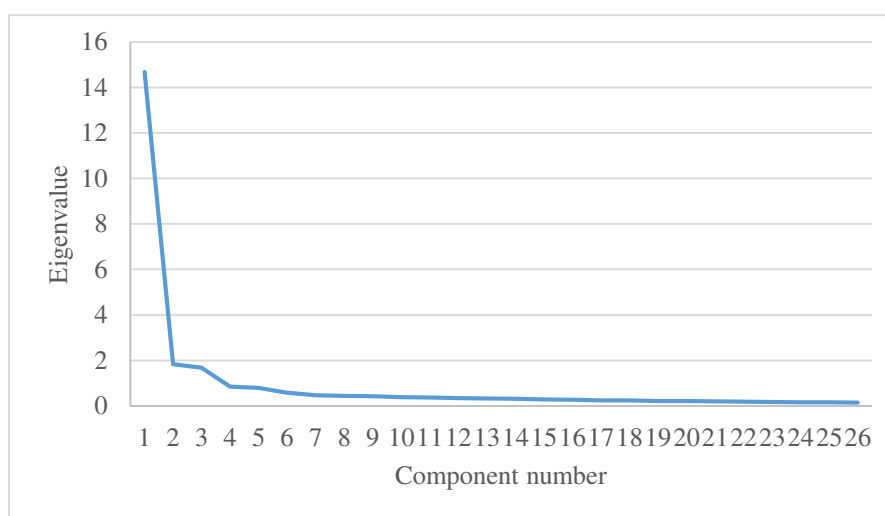
## Appendix 1

### Literature review

Limitation	No. of sources:
All fields with cybersecurity.	12,164
Only articles.	5,718
Category (Computer Science, Information Systems, Social Science, Business, Education, Behavioural Sciences, Sociology Sciences).	2,256
Titles review (we rejected articles describing cybersecurity models& frameworks, legal acts, regulations, technology applications, focus on threats and its nature).	1,182
Based on a review of titles supported by a review of abstracts in justified cases we selected a body of articles on cybersecurity and people, behaviour, employees and scales.	368
Based on the abstracts review, we selected the articles for literature review.	182

## Appendix 2

### Screen plot



## APPLICATION OF ASSOCIATION RULES IN FILLING GAPS IN SURVEY DATA

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**Purpose:** Surveys are one of the most popular data acquisition tools used in economics and management sciences. The results of surveys provide a lot of information and allow for fast response to changes in the socio-economic environment. Unfortunately, in many cases there are missing data in surveys, which can be caused by various reasons.

**Design/methodology/approach:** One of the most common reasons are the respondent's reluctance to provide an answer or distraction while completing the questionnaire. This study presents a novel approach for filling gaps in the survey data.

**Findings:** The main idea of the proposed method is to use the associations between the answers to given sets of questions for different respondents.

**Originality/value:** The obtained association rules were used as input variables and a number of well-known machine learning tools were applied for filling data gaps. The results of numerical experiments confirmed a very high performance of the proposed novel method for filling data gaps in surveys.

**Keywords:** Surveys, association rules, filling data gaps, Fuzzy Rule, Random Forest.

**Category of the paper:** Research paper.

### 1. Introduction

The diversity of research interests in the field of economic sciences (Baumans, Davis, 2010) is associated primarily with the breadth of research issues (Bennet, 2006; Burke, Morley, 2016). In social sciences, individual disciplines of economic sciences (Düppe, 2011; Farmer, 2013) have the characteristic which could be defined as multi-paradigmaticity (Friedman, 2009;

Keizer, 2015), which translates into research methodologies (Eriksson, Kovalainen, 2016), and then its interpretation.

The division into quantitative and qualitative methods is the basic division of methods in research sciences (Kam, Lai, 2018). Quantitative methods make it possible to process with statistical tools (Ferreira, Cova, Spencer, Proença, 2017), but the results are more general. Qualitative methods allow for in-depth observation of special cases (Gerring, 2007), but the data cannot be generalised per population. In order to select the correct methods and techniques for the study, it is necessary to start with the objectives of the study and research questions (Jap, Anderson, 2007). Correctly formulated goals and questions (Wade, 2004; Williamson, 2009) impose a certain minimum set of research methods, without which it will not be possible to answer the questions asked.

Surveys are the basic technique used in quantitative research (Miterev, Mancini, Turner, 2017). Depending on the methods of reaching the respondent, the following types of quantitative research can be distinguished (Lee, Johnsen, 2012): CATI (Computer Assisted Telephone Interview), PAPI (Paper and Pencil Interview), CAPI (Computer Assisted Personal Interview), CAWI (Computer Assisted Web Interview). Obviously, it is desirable and necessary to expand this set in order to multiply the methods (i.e. the so-called triangulation) and increase the quality of evaluation. Triangulation consists in the multiplication of methods, techniques and data sources) in order to confront the received information and summarise it, and allows to reduce measurement errors (Maylor, Turkulainen, 2019) and increase the quality of the study. The test results then become less error-prone and therefore more reliable. In order to increase the resistance of the research to errors, we can multiply: research methods and techniques, information sources, types of data and analytical techniques, explanatory theories, the number of people carrying out the research (Restuccia, Legoux, 2019). This makes it possible to detect and correct examination errors by crossing different viewpoints.

Testing on a sample can never absolve the researcher from error. The choice of the error size depends on the subject of the study and the level of accuracy at which we want to study a given population (Samimi, Sydow, 2021). To minimise the error it is necessary to increase the sample size. Thus, the choice of the tolerable error rate is usually a trade-off between the cost and quality of the audit. In management sciences, if there is a mistake or a gap in the study, the questionnaire/interview is usually eliminated as an incomplete data set.

Currently, in the field of social sciences a mixed approach (Molina-Azorin, 2016) is recommended, including management and quality sciences (Harrison, Reilly, Creswell, 2020), among others in the area of strategic management (Molina-Azorin, 2011; 2012). Research "involving at least one quantitative method (designed for collecting numbers) and one qualitative method (designed for collecting words) in which no type or method of research is inherently tied to any particular research paradigm" (Greene, Caracelli, Graham, 1989, p. 256) are very important. Therefore, attention was paid to the elimination of future errors and gaps and the use of a mixed approach, which we should conduct when researching study areas in

which the results so far have been ambiguous and/or fragmentary, and therefore there is no reliable and holistic knowledge (Johnson, Onwuegbuzie, 2004), or else identification of complex research problems and phenomena takes place (Molina-Azorin, 2012; 2016; Bazeley, 2015; Hong, Pluye, 2019). Therefore, in order to avoid the error of the research sample, it is necessary to use a mixed approach, because the importance of research, its results and conclusions drawn on their basis increases (Molina-Azorin, 2011; Gibson, 2017; Harrison, Reilly, Creswell, 2020), as a result of which generalisation becomes more authorised (Denscombe, 2008), the interpretations are more accurate (Gibson, 2017) and a more in-depth and more comprehensive interpretation of the results takes place, which allows for a more comprehensive picture of the phenomenon under study (Molina-Azorin, 2011).

Surveys have played a huge role, but when used in a mixed approach, they affect the originality of the course of research and the results obtained as a result, as well as the generally achieved level of methodological rigour (Molina-Azorin, 2012; Bazeley, 2015). Moreover, the applied triangulation of data and methods (Chen, 2006), but also the combination of multidimensional advantages of the quantitative and qualitative approach (Chen, 2006; Molina-Azorin, 2012; 2016; Harrison, Reilly, Creswell, 2020) influence the interpretation and elimination of research gaps.

The problem of filling gaps in data is a widely considered issue. Due to its numerous applications, it is of interest to many researchers and new methods of filling in missing data are constantly being developed (Zhang, 2016; Jerez, 2010; Bertsimas, 2017). Among the many approaches, the methods using fuzzy sets (Kiersztyn, 2020) or machine learning (Whitehead, 2019) deserve special attention. In many cases, missing data are a special case of anomalies or outliers that can also be detected and classified (Kiersztyn, 2020; 2020) and then modified to be more consistent with the rest of the dataset.

This paper proposes an innovative combination of many known machine learning techniques. The starting point was the unusual use of association techniques to define the explanatory variables. Based on the relationship between the individual variables resulting from the basket analysis, the process of supplementing data gaps was carried out with the use of selected techniques used for classification. The paper considers a special type of data, which are the results of surveys typical for research in the field of economics and management. The proposed solution, due to its intuitiveness and ease of adaptation, can be successfully used by researchers who do not have much experience in the use of machine learning.

The structure of the work is as follows. Section II describes the dataset on which the research was performed. Then, Section III provides a description of the methodology used for filling data gaps. In the next Section IV, the results of numerical experiments are presented. The last Section V is devoted to conclusions and future work directions

## 2. Description of the data set analysed

The research used in this article is part of a research project under the name of "Teal organisations in Economy 4.0" (Rzepka, 2020; 2021; 2022). The project involves conducting research in Poland (Maciaszczyk et al., 2023; Miśkiewicz et al., 2021), and in selected countries of the world (USA, Georgia, Slovakia, Brazil, England, Romania, Czech Republic, Ukraine, Spain). The research is conducted in stages and includes a pilot study (N = 300), core research (N = 300 PL and 330 different countries) and repeat research (N = 300). It was a relatively extensive survey distributed among top management from different countries. The questionnaire consisted of parts devoted to different topics, like general information, innovation and technology, relationship, social capital, knowledge and information, trust, structure, organisational culture, associations and personal profile), and each part had 5 to 7 questions. The aim of the survey was to examine the extent to which contemporary companies cooperate with consumers and exhibit the characteristic features of Teal organisations (Rzepka, 2023; Miśkiewicz et al., 2021) as well as the extent to which these features influence various aspects of the operation of the company, including its ability to innovate. It should be noted that agility remains an inherent characteristic of Teal organisations (Rzepka, 2023).

The study was divided into stages that includes a pilot study (May-June 2020), stage I: quantitative study (July-September 2020) and stage II: December 2020 – January 2021. One top management representative of each enterprise was asked to participate in the survey. The choice of enterprises resulted from the SMEs' availability. Moreover as a part of the survey 15 structured direct interviews were conducted in Polish companies. These interviews constitute the pilot studies for further stages of direct interviews in other countries participating in the research.

It is worth presenting the results of research from the aforementioned project. The study has been and will be conducted according to the principles and standards developed by the Network on Development Evaluation of the OECD Development Assistance Committee (DAC). The following work was carried out in the course of the study – Desk research; IDI (Individual In-Depth Interview), and questionnaire study with selected groups of people using Computer-Assisted Web Interview (CAWI) and Paper and Pencil Interview (PAPI) techniques.

At each stage, a sample of 300 respondents from various micro, small and medium-sized enterprises, with different levels of coverage and size, was selected (Table 1).



**Table 1.***Scope of respondents*

		Pilot	I stage	II stage
Predominant mode of the company's operation (%)	Commerce	19.7	10.3	16.6
	Production	17.6	13.9	28.0
	Services	62.7	75.8	55.4
Scope of the company's activity (%)	Local	19.3	22.1	9.4
	Regional	8.2	12.4	27.3
	National	30.0	23.0	22.0
	International	42.5	42.4	41.3
Number of employees (%)	0-9	13.7	9.1	3.3
	10-49	24.0	18.8	55.1
	50-249	15.5	28.2	16.6
	250-999	18.5	20.9	16.6
	1000 – and more	28.3	23.0	8.4

The survey included top-level employees from companies with 50-249 employees (28.3%) with an international scope (42.5%), while the largest number of respondents in Stage III represented service companies (55.4%), located in multinationals (41.3%) and employing an average of 10-49 people (55.1%). Within the industry, as many as 11.4% represented the IT industry during the period under review.

### 3. Methodology for filling gaps in data

When supplementing the missing survey data, the characteristics of the analysed set should be taken into account. The most intuitive way to fill in the missing data in the questionnaires is to use the mean or median of the answers determined on the basis of the available data. This approach does not take into account the nature of the question, but only estimates the missing value based on the basic properties of the distribution of answers. This approach, despite its simplicity, can yield relatively good results. In the proposed approach, we will use a slightly more complex approach that produces much better results. The starting point of the proposed solution is the application of association rules to fill in missing data. In the case of survey data based on the Likert scale, there is a finite number of combinations of possible answers. Therefore, it is possible to determine basic measures describing the dependencies occurring in association rules for all possible sets of answers. The most important measure in the case under consideration seems to be the trust set by the formula

$$confidence(X, Y) = \frac{supp(X \cup Y)}{supp(X)} \quad (1)$$

where the support is set by the formula

$$supp(X) = \frac{\#X}{N} \quad (2)$$

which denotes the percentage of rules where the value of X occurs.

In order to increase the clarity of considerations, let us introduce the following symbols and the necessary assumptions. Assume that the dataset analysed consists of a set of  $N$  questions  $Q_1, Q_2, \dots, Q_N$ , each of which uses a  $K$  graded Likert scale. It is possible to make the number of available answers dependent on the question number and thus allow the use of a different scale for individual questions. However, such an option will significantly reduce the transparency of the record, and on the other hand will not bring additional benefits. The proposed innovative method does not depend on the number of questions, while the introduction of additional indices will reduce the transparency of the theoretical part. To summarise, for the  $n$ -th of  $N$  questions, possible answers belong to the set  $\{X_1^n, X_2^n, \dots, X_K^n\}$ . Most often, the values  $X_j^n = j, j = 1, 2, \dots, K$ , however, it is possible to introduce a different scale and we will not introduce this limitation.

On the basis of the available data, it is possible to determine the confidence value (1) for each combination of questions and possible answers, i.e.

$$confidence(X_j^n, X_i^m)$$

for  $i, j \in \{1, 2, \dots, K\}, n, m \in \{1, 2, \dots, N\}$ .

The values obtained in this way are the starting point for filling gaps in the data. If for a certain respondent there is no answer in the question  $Q_n$ , then the remaining available data for that respondent should be analysed and on their basis the chances of the occurrence of each of the possible answers  $\{X_1^n, X_2^n, \dots, X_K^n\}$  should be estimated. More precisely, based on the answers to the remaining questions, the values of the confidence measures for the respective combinations are summed up. As a result, the CON vector of aggregated values of the confidence measure is obtained

$$CON = [con(X_1^n), con(X_2^n), \dots, con(X_K^n)] \quad (3)$$

where

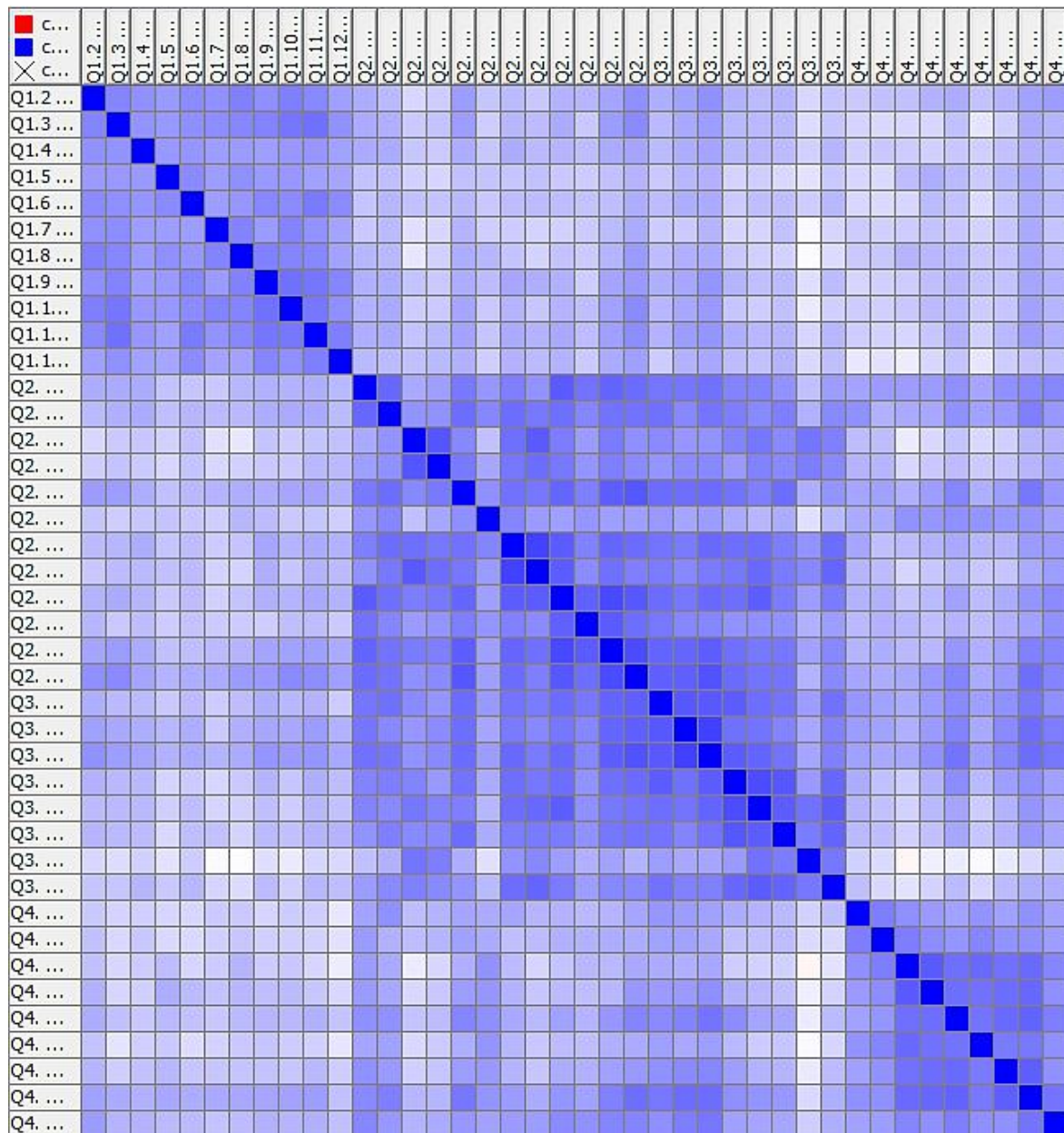
$$con(X_i^n) = \sum_{j=1}^K \sum_{m \neq n}^N confidence(X_j^n, X_i^m) \quad (4)$$

For the suggested value, choose the answer for which the value of the aggregate confidence measure is the highest. The results obtained with this novel application of the classic machine learning tool are very promising, as shown in the experimental section.

## 4. Experimental results

In order to test the effectiveness of the proposed method, a series of numerical experiments were performed on the data set discussed in Chapter 3. More precisely, 40 questions were selected for the analysis, for which there is an economic justification for the existence of relationships between the individual answers. Each of the analysed questions made it possible to select one of the 5 answers according to the Likert scale as the answer. In the first step,

the correlation between the individual variables was determined for the available data (cf. Fig. 1). The values of the linear correlation coefficient will be used in the following to weight confidence measures between individual responses.

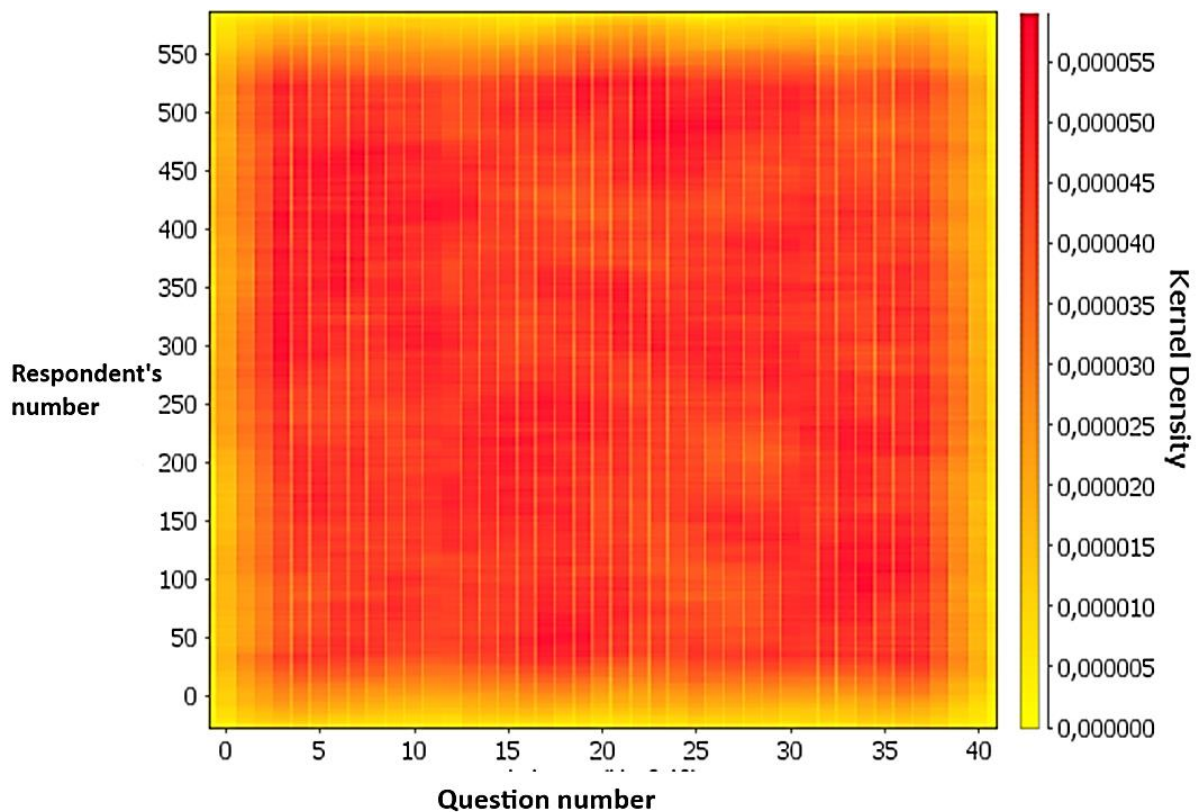


**Figure 1.** The level of Pearson's linear correlation between the considered variables corresponding to the individual questions in the survey.

Analysing the results presented in Fig. 1, it can be seen that for some pairs of questions there is a relatively high relationship, which is well illustrated by a linear correlation. This observation will be used later in the experimental section. Apart from the correlation between the individual ones, before the artificial introduction of gaps, the values of the confidence measure were determined for all possible answers and questions. Thus, a square CONF matrix with dimensions of 200x200 was determined. It should be noted at this point that this matrix is obviously not symmetrical. Having the necessary values, it was possible to test

the effectiveness of the proposed solution by introducing random gaps in the data corresponding to the failure of the respondent to answer a given question.

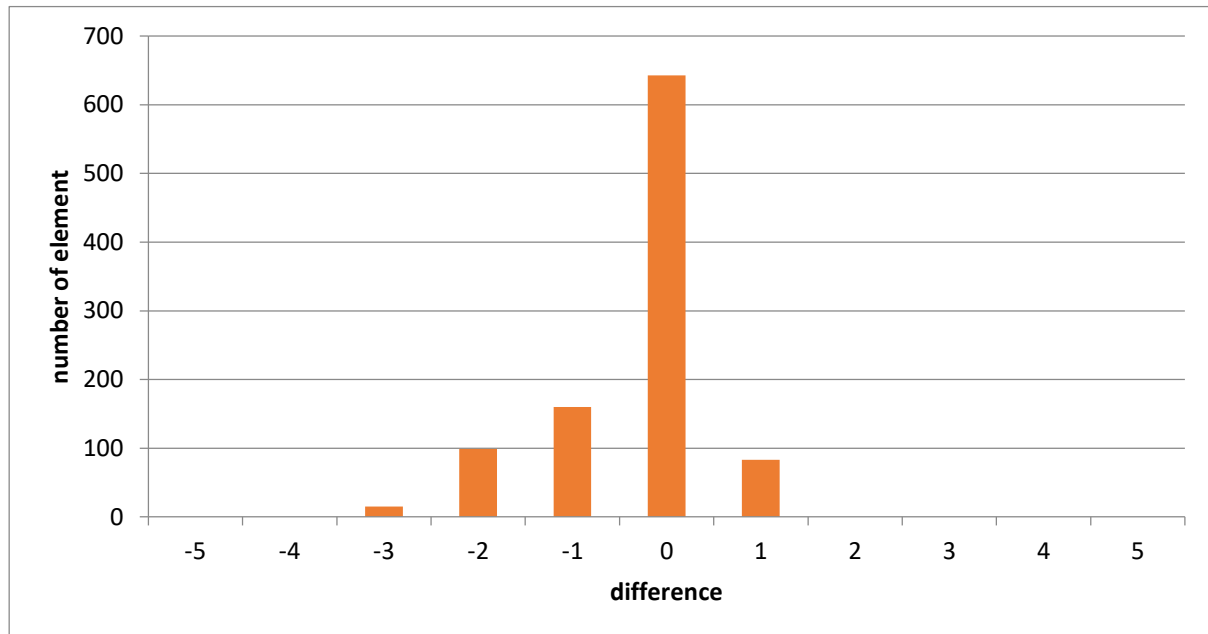
Data gaps were generated according to a uniform distribution in a two-step manner. In the first step, the respondent (a row in the data table) was selected, and then the question (a column in the data table). This draw was repeated each time a predetermined number of repetitions, while the possibility of repetitions was allowed, which was necessary in the case of indicating a large number of repetitions. The empirical distribution of the randomly selected positions of the gaps is shown in Fig. 2.



**Figure 2.** Distribution of items of randomly selected missing data in the analysed data set.

In the next step, for each of the gaps, the vector of aggregated confidence measures was determined for the remaining 39 questions in two ways. In the first approach, the sum of the values of confidence measures was calculated after the appropriate pairs of responses, i.e. in other words, the suitable values from the CONF matrix were summed. Then the obtained values were normalised in such a way that the sum of the components of the vector CON was 1. The position of the highest value of the vector CON corresponds to the most probable value that has been removed. In the second approach, a slight modification was introduced, consisting in the use of additional weight when summing the appropriate elements of the CONF matrix. The measure used was the value of the correlation coefficient between the individual questions. Two competing solutions were thus obtained.

Very satisfactory results were obtained in the case of generating 1000 gaps and applying the simplified version of missing data filling using only association measures. In 643 cases, correct restoration of deleted values was obtained. The distribution of differences between the real value and the result obtained with the proposed method is shown in Fig. 3.



**Figure 1.** Distribution of differences.

The results presented in Fig. 3 show that when the correct answer was not given, the difference between the real value and the model was small and only in 15 was it greater than 2.

If the proposed method of supplementing missing data is enriched by applying an additional weight corresponding to the correlations between the questions, even better results are obtained. In 706 cases, the deleted value was perfectly reproduced and the differences between the empirical and theoretical values were even smaller, cf. Fig. 4.

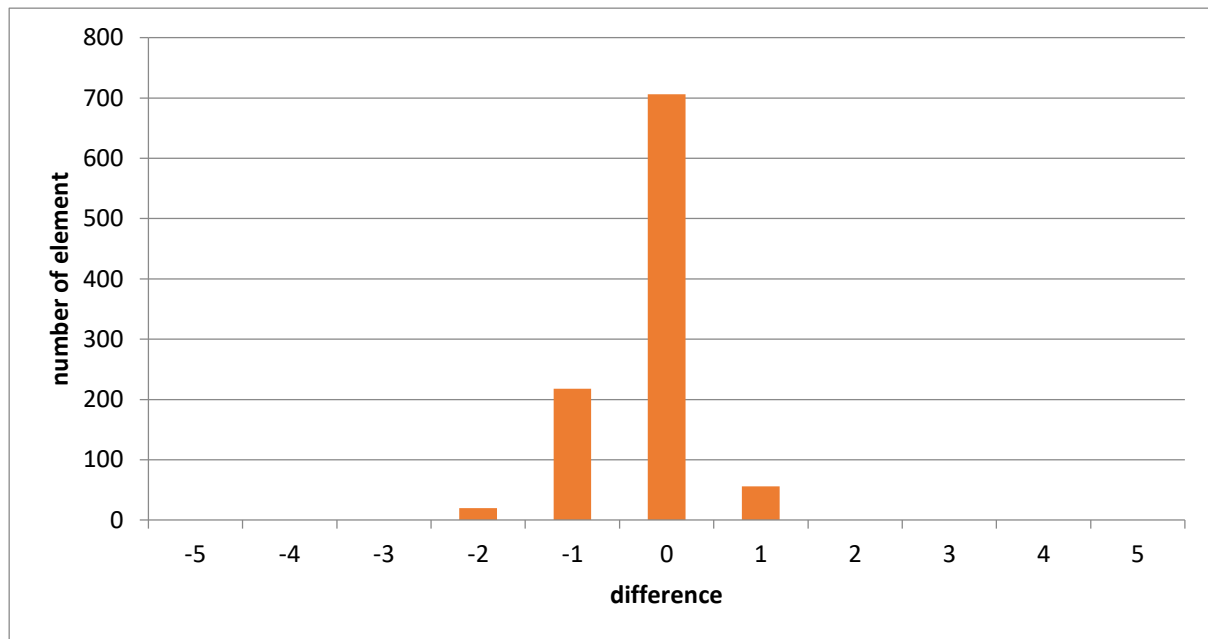


Figure 2. Density of differences.

Additionally, it is worth noting that if we consider the second of the suggested answers, then in the typed pair of values with a probability of 0.965 there is actually the deleted value. This observation suggests the use of additional analyses involving the addition of machine learning techniques to determine the removed value based on the values of the CON vector.

It turns out that the use of additional machine learning tools can significantly increase the effectiveness of the proposed solution. For example, for the data containing the CON vector values for individual 1000 artificially generated missing data, several well-known classification methods were used (Kiersztyn, 2021a). The methods implemented in KNIME were selected for the analysis, namely FuzzyRule (FR) (Berthold 2003), RandomForest (RF) (Pal, 2005), TreeEnsamble (TE) (Coppersmith, 1999), Gradient BoostedTree (GBT) (Friedman, 2002). As is generally known, the random allocation of elements to the training set has a huge impact on the effectiveness of the classification (Kiersztyn, 2021b), in order to eliminate the impact of the randomness of the division within each division of the available data on the training and test sets, 10 independent repetitions of the test were performed. The averaged results for different partitions are presented in Table 2.

**Table 2.**

*Classification efficiency depending on the size of the training set*

Percentage of elements in the training set	FR	RF	TE	GBT	DT
5	83.624	97.263	97.368	94.421	88.526
10	99.204	99.111	99.111	99	93.333
15	97.934	98.706	98.353	96.706	97.765
20	99.493	99.125	99.625	96.750	96.500
25	99.454	99.867	99.867	99.867	99.867
30	100	100	100	99.714	99.143
35	100	100	100	100	100



For a greater percentage of elements in the training set, all values are equal to 100 for each method. Analysing the results presented in Table 1, we can see that, regardless of the classification method used, we obtain very high classification efficiency for small teaching sets. It turns out that in many cases the algorithm was able to correctly classify the remaining values on the basis of 30% of the elements classified to the training set. It should be noted here that even in the event of an incorrect classification, the difference between the actual state and the theoretical value is small, as evidenced by the example of the RF classification result for 5% of the elements in the training set is presented in Table 2.

**Table 3.**

*An example of the results of classification by the RF Method*

Real value/Predicted value	1	2	3	4	5
1	77	16	0	0	0
2	1	142	16	0	0
3	0	0	222	18	0
4	0	0	0	274	11
5	0	0	0	8	165

It can be seen that the prediction differs at most by one value from the actual state and usually the RF method, as well as the others, overestimate the predicted value. It should be noted here that the above values presented in Table1 and Table2 are obtained when the analyses are performed based on the value of the CON vector and the number of the column in which the value was removed. In other words, during the analysis, the information was available from which question the value was removed. Information about the respondent's number has not been added to the set of explanatory variables. If the information about the number of the question from which the analysed value has been removed is omitted, the effectiveness changes slightly. By repeating the entire classification process for a smaller number of explanatory variables, the results presented in Table 3 were obtained.

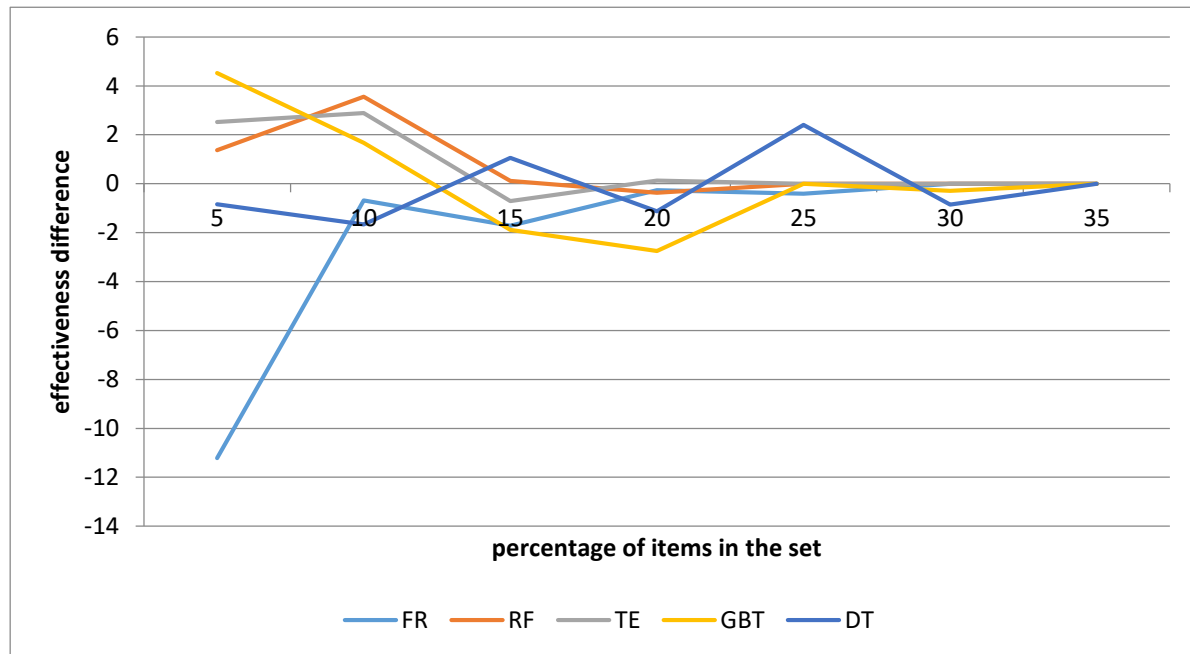
**Table 4.**

*Efficiency of individual methods on a limited number of explanatory variables*

Percentage of elements in the training set	FR	RF	TE	GBT	DT
5	94.842	95.895	94.842	89.895	89.368
10	99.887	95.556	96.222	97.333	95
15	99.647	98.588	99.059	98.588	96.706
20	99.757	99.500	99.500	99.500	97.625
25	99.867	99.867	99.867	99.867	97.467
30	100	100	100	100	100

Comparing the results presented in Table 1 and Table 3, it should be noted that in the case of the FuzzyRule (FR) method, reducing the number of variables, i.e. limiting information, surprisingly increased efficiency. Similarly, in the case of DecisionTree (DT), removing the number of the analysed question information tended to increase efficiency. The reasons for such

a state can be found in the randomness of the data division into the training and test sets. Nevertheless, due to the repetition of experiments for the two compared approaches, the impact of randomness seems to be limited. The differences between the effectiveness of individual methods with and without available information about the analysed question (column) are shown in Fig. 5.



**Figure 5.** Differences in the effectiveness of individual methods for different explanatory variables.

Analyzing the results presented in Fig. 5, we see that as the number of elements in the training set increases, the efficiency increases. This is an obvious phenomenon, but achieving full compliance with 30% of the elements in the training set is a very good result. Moreover, there are slight differences between the compared methods.

## 5. Conclusion and future work

The proposed innovative approach to filling gaps in data in questionnaire surveys has a number of practical applications. In many cases, the results of the surveys carried out contain gaps in the data due to various factors. Very good results have been achieved thanks to the appropriate use of machine learning tools, in particular thanks to the skillful combination of different approaches. In the experimental section, the effectiveness of the proposed solution was confirmed, showing that on the basis of a small number of training sets, it is possible to obtain 100% correctness in recreating artificially generated data gaps. Moreover, the obtained results indicate a high potential for conducting interdisciplinary research and supporting researchers in the field of management with the great possibilities of artificial intelligence tools.



It is planned to extend the research to survey questions in which the answers are not limited to the Likert scale. In addition, work is underway on the use of other classification techniques and testing of the obtained solutions on other datasets that do not necessarily describe survey research.

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## IT ADAPTABILITY ROLE IN SHAPING ORGANIZATIONAL PERFORMANCE IN VUCA ENVIRONMENT

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**Purpose:** The aim of this research is to verify whether the characteristics of the environment are strengthening the influence of IT adaptability on organizational performance.

**Design/methodology/approach:** In order to verify the potential relations, empirical studies were conducted in 1160 organizations located in Poland, Italy, and the USA. The CAWI method was used in this research, while the companies were selected on the basis of the purposive manner. The reliability of the scales used in the survey was tested and afterwards the moderation model was built, confirming the presumed relationships between the variables.

**Findings:** It has been proven that the more VUCA the environment is, the stronger the influence of IT adaptability on organizational performance.

**Research limitations/implications:** The limitations of the research include: performing analyzes only in three countries, purposeful sampling, data collection period, and the application of selected constructs to the model. The future studies proposals included in the article are aimed at reducing cognitive space.

**Practical implications:** Research results can support organizational managers who, by ensuring IT with appropriate characteristics (such as IT adaptability), are able enhance organizational performance in turbulent and difficult environmental conditions.

**Originality/value:** The research enriches existing knowledge in the field of organizational performance. Including the issue of IT adaptability in considerations in this area allows for providing support to organizations operating in conditions of uncertainty.

**Keywords:** management, IT adaptability, VUCA environment, crisis management, black swan event, organizational performance.

**Category of the paper:** Research paper.

## 1. Introduction

Existing theories in the area of organization management, such as Resource-Based View (RBV) or extended Knowledge-Based View (KBV), although they are very well embedded in the literature, seem to insufficiently describe the current global situation (Zhang-Zhang et al., 2022). Turbulent environmental conditions, high level of uncertainty, threats to ensuring business continuity and diversity, intensity, and rapidity of occurring phenomena have resulted in an increase in interest in the VUCA concept (Ciolacu et al., 2023; Rimita et al., 2020). Volatility, uncertainty, complexity, and ambiguity (VUCA) are features of the modern reality in which operating organizations must use various activities in order to survive. Changes have become the new constant, and adapting to them has become the main challenge faced by managers of organizations (Du, Chen, 2018). Emerging crises or even black swan phenomena, which not only affect entire societies, but also interrupt the existing activities of entities on the market, should be not forgotten (Bieńkowska et al., 2022; Zabłocka-Kluczka, Salamacha, 2023). One of the opportunities to cope with such difficult conditions seems to be the use of advanced technologies to support organizational activities, including widespread digitization and the use of IT tools (Caporuscio et al., 2023). Numerous researchers have investigated the important role of utilize digital technologies in building organizational resilience and overcoming challenges in the VUCA reality (Khalil et al., 2022; Khurana et al., 2022; Strotmann et al., 2022). It seems, however, that despite the good recognition of this issue, not all aspects have been explored. The ability of IT to adapt to changes, so important due to the lack of stability of the environment, is still underrepresented. Bernardi (2023) in research on the implementation of innovative telehealth solutions during the crisis caused by the Covid pandemic, showed the benefits that resulted from IT adaptability to ensure public safety. The author indicated that this is an area around which the interest of researchers should focus. Zia et al. (2023) seem to agree with this statement. The authors indicated the impact of digital dynamic capabilities (which include IT adaptability) on the success or failure of the organization. Researchers believe that this is an appropriate direction for further research, as many factors remain unrecognized. Therefore, the research gap was identified.

Bearing in mind the above the aim of the paper is to verify whether the characteristics of the environment are strengthening the influence of IT adaptability on organizational performance. The aim will be fulfilled by critical literature analysis, which will be a basis for hypotheses development and by empirical research aimed at verification of the hypotheses.

## 2. Theoretical background

### 2.1. VUCA environment

In today's rapidly changing world, the concept of VUCA—Volatility, Uncertainty, Complexity, and Ambiguity—has become increasingly pertinent in the field of organizational management and strategic planning. Initially introduced by the U.S. military (U.S. Army..., 2022), it later transitioned into the business world and is now used to describe the unpredictable nature of the global business environment (Bennett, Lemoine, 2014). VUCA provides a framework for comprehending and addressing the challenges caused by an unpredictable and turbulent environment. The framework emphasizes four key components, which have distinct characteristics:

**Volatility:** This refers to the speed and magnitude of change, encompassing unpredicted and frequent shifts in market conditions (Bennett, Lemoine, 2014), technology advancements (Hall, Rowland, 2016), and global events that can disrupt systems and norms (van der Wal, 2017).

**Uncertainty:** Uncertainty relates to the lack of predictability in numerous future events (Gläser, 2023), often attributed to the lack of information on whether the event will have meaningful consequences (Bennett, Lemoine, 2014), making it challenging for organizations to anticipate outcomes or trends accurately.

**Complexity:** Complexity signifies the intricacy and interconnectivity of issues and factors that influence decision-making, which are hard to understand (van der Wal, 2017) and require a holistic perspective to recognize the multifaceted nature of challenges.

**Ambiguity:** Ambiguity deals with the blurred lines of cause and effect, making it difficult to discern patterns and make clear, straightforward decisions due to the lack of prior examples and relevant historical data (Bennett, Lemoine, 2014). Moreover, ambiguity interferes with the company's ability to learn from such events (Garud et al., 2011).

Some scholars refer to VUCA not regarding the general organizational environment but in terms of the specific business process or activity. In particular, (Raghuram et al., 2023) are addressing “the volatility in supplies, uncertainty in demand, complexity in getting the product and ambiguity in understanding the issues” for a biomedical manufacturer.

Today, the main events defining the VUCA context and considered by scholars are the COVID-19 pandemic (Zhang-Zhang et al., 2022), significant economic downturns, disrupted supply chains, deglobalization, Russian aggression in Ukraine (Mahajan, Baride, 2023), technology-intensive conditions. Outlining the extreme dynamics of the modern VUCA world (Peschl, 2023) due to the simultaneous multi-level crisis events (Zhang-Zhang et al., 2022), authors are thriving to suggest the appropriate way to create impactful and sustainable innovations in such conditions by learning from the future (Peschl, 2023) introducing advanced

digital technologies to manage supply chains (Akyuz, Gursoy, 2020), transforming leadership styles (Amin et al., 2019), real-time data processing (Lechler et al., 2019).

Researchers recognize that VUCA is not confined to a single sector or industry. It transcends boundaries and affects various contexts. Therefore, scholars investigate managerial approaches and ways to successfully operate in such an environment across industries, e.g., in the energy sector (Giones et al., 2019), agriculture (Germundssona et al., 2021) public services (Gaule et al., 2023). Strategies for navigating VUCA are being developed for different organization sizes. Agility is of strategic importance for SMEs, and its three precursors include capabilities of digital technologies, relationships, and innovations (Troise et al., 2022). Shams et al. (2021) view strategic agility, including supply chain agility, IT agility and sustainable and agile production, as a crucial strategic approach for multinationals.

In conclusion, the VUCA framework provides a valuable lens through which to view the challenges and opportunities presented by our ever-changing world. Organizations across different sectors need to acknowledge the VUCA environment and implement strategies that enable them to thrive amidst volatility, uncertainty, complexity, and ambiguity. In a VUCA world, adaptability, innovation, and strong leadership are the cornerstones of success, and organizations that embrace these principles are better equipped to excel in an unpredictable future.

## **2.2. IT adaptability**

In the twenty-first century, organizations faced increasingly uncertain and rapidly changing conditions. Even before the emergence of the COVID-19 pandemic, which multiplied those characteristics, adaptation was perceived by various scholars as fundamental for the survival and success of the organization (Baard et al., 2014; Marques-Quinteiro et al., 2018).

Moreover, adaptability was considered by scholars as one of the four characteristics of organizations that shape their resilience. According to (Vogus, Sutcliffe, 2007), adaptability, preparedness, responsiveness, and learning are drivers of organizational resilience, defined as "the maintenance of positive adjustment under challenging conditions such that the organization emerges from those conditions strengthened and more resourceful". Various authors consider adaptability as the most important driver of resilience, allowing organizations to recover from crises (Koronis, Ponis, 2018).

Adaptability is a characteristic that may be used to describe various elements of an organization. The common understanding for all of them is placing adaptability as a characteristic connected to the ability to easily change (Almutairi, Ghandour, 2021). In the context of organization, adaptability is defined as an organization's capacity to continuously change its strategy and competencies in response to environmental conditions (Albaum, Tse, 2001).



Adaptability of IT should be treated as a derivative of such understanding, as IT is considered an element of organization from the management sciences perspective (Beynon-Davies, 2013). IT adaptability is crucial in supporting the organization's operations in a VUCA environment.

The notion of IT in the organization has been analyzed in two primary research areas: IT-business alignment and IT dynamic capabilities. These areas emphasize the need for IT to adapt and support the organization in turbulent conditions (Heart et al., 2010).

At the center of all this research are three characteristics/capabilities of IT known as the three AAA – agility, alignment, and adaptability (Patrucco, Kähkönen, 2021). These concepts are essential in the post-COVID-19 era, where agility involves responding to short-term changes, alignment focuses on matching organizational needs with IT capabilities, and adaptability centers on adapting to both short-term and long-term changes.

IT adaptability is a broad notion originating from the ISO/IEC 25010 norm, defining it as "the degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software, or other operational or usage environments" (ISO/IEC25010:2011, 2011). IT adaptability is critical in accommodating changes in user requirements or the environment (Almutairi, Ghandour, 2021).

IT adaptability encompasses both system-based and organization-based aspects (Ngo-Ye, Ahsan, 2005). The system-based perspective focuses on IT's inherent qualities, such as scalability, modularity, and interoperability, while the organization-based perspective pertains to how IT is used within an organization and its adaptability in specific circumstances.

To address the gaps in research on IT adaptability in organizations, it is essential to consider the adaptability of IT within the context of an organization's specific needs and usage patterns. This perspective underscores the need for a mechanism that allows organizations to benefit from adaptable IT and support its proper use.

Some immanent qualities of IT itself are associated with IT adaptability, both system-based (scalability, modularity, independence, interoperability, self-organization, design, self-similarity, availability) and organization-based (structural analogy, knowledge, redundancy, customizing) (Groenewald, Okanga, 2019). Decisions regarding the deployment of IT systems within a business organization significantly influence the degree of adaptability that can be achieved (Gronau, Rohloff, 2007).

While various authors have explored IT adaptability in the context of organizations, the coverage of this field of study remains relatively limited (Liu et al., 2019). Understanding IT adaptability requires considering both the phase of developing new IT systems and their adaptability, as well as how IT is used within an organization over time (Boland, Hirschheim, 1987).

In conclusion, adaptability is a crucial attribute for organizations to thrive in a rapidly changing world. IT adaptability, as a subset of this concept, plays a pivotal role in enabling organizations to respond effectively to evolving conditions and crises. The study of

IT adaptability encompasses system-based and organization-based aspects, highlighting the need for IT to not only possess inherent adaptable qualities but also to be utilized effectively within the organization's specific context. Further research is needed to deepen our understanding of IT adaptability and its impact on organizational resilience and performance.

### **2.3. IT adaptability and organizational performance**

The relationship between IT adaptability and organizational performance, particularly in the context of environment characteristics, is a subject of increasing importance in the literature. The core idea is that adaptability, in the context of the entire organization, plays a significant role in influencing overall performance. This concept is structured as follows: the context affects adaptability, which, in turn, influences behaviors, ultimately shaping organizational performance. This framework is crucial in developing models that examine the influence of a specific type of adaptability, IT adaptability, on the entire organization (Tworek, 2023).

The literature often references the IS Success Model (DeLone, McLean, 2003), which includes IT resources, IT capabilities, and IT-business alignment (Jacks et al., 2011), all of which can mitigate adverse effects on an organization's performance. Various studies have supported the idea that adaptable IT positively impacts organizational performance (Darvishmotevali, Ali, 2020; Wanasida et al., 2021). Adaptable IT supports the implementation of strategies and facilitates quick decision-making (Stank, Lackey, 1997), making it a critical factor during crises. IT adaptability also connects to organizational sustainability, indirectly influencing performance (Zeng, Lu, 2021), even during crises.

The literature discusses the role of IT adaptability in influencing organizational performance through job performance (Tworek, 2023). Adaptable IT enables employees to perform their tasks effectively, especially in VUCA environment. It supports task redesign, a necessity in VUCA environment, which forced organizations to change how they operate (Gössling, Schweiggart, 2022). Adaptable IT helps maintain performance and facilitates government support for business redesign.

In today's organizations, where IT is integral to the workforce, the relationship between employees and technology is paramount (Weisbord, 1976). This is even more crucial in the context of IT adaptability, which undergoes changes, especially in VUCA environment. Adaptable IT influences organizational performance through job performance, but only when employees actively use it (Kabra et al., 2017).

It can be assumed that IT adaptability not only directly influences organizational performance but also shapes the dynamic capabilities of the organization by supporting its employees. This indirect role, as a support for employees who drive the organization's dynamic capabilities, may be more critical for enhancing overall performance than its direct impact.

In conclusion, the literature suggests that IT adaptability positively influences organizational performance. Adaptable IT plays a pivotal role in enabling organizations to navigate challenging times and maintain their performance through the efficiency and effectiveness of their workforce. Therefore, the following hypothesis can be formulated:

H1: IT adaptability is positively influencing organizational performance.

#### **2.4. IT adaptability, organizational performance and VUCA environment**

Agility and utilization of emerging informational technologies are defined as effective strategies for navigating the challenges, posed by the VUCA world. According to Peschl (2023), events of the VUCA environment are the triggers for learning and (radical) transformations that are necessary for organizational success. Therefore, he poses, it is “not sufficient to have only well-established stimulus-response patterns/routines in place”. Cavusgil et al. (2021) discussing the prerequisites of organizational performance of international businesses, suggest that in the VUCA environment, they should adopt an active strategy of advancing their technological capabilities through new partnerships, targeted investments and joint ventures with IT startups and digital entrepreneurs to stay successful in the race for innovations.

In turbulent environments, adaptability is essential for an organization's survival and its ability to maintain performance (Almutairi et al., 2022). The authors' exploratory study, conducted in 2021, confirms that companies recognize the value of IT adaptability in terms of cost saving and organization's competitiveness. Other researchers also argue that a company can obtain a higher level of strategic agility, needed in the VUCA environment, through more flexible IT resources (Pinsonneault, 2011). In turn, their findings indicate that environmental volatility has a positive moderating effect on the relationship between agility and firm performance.

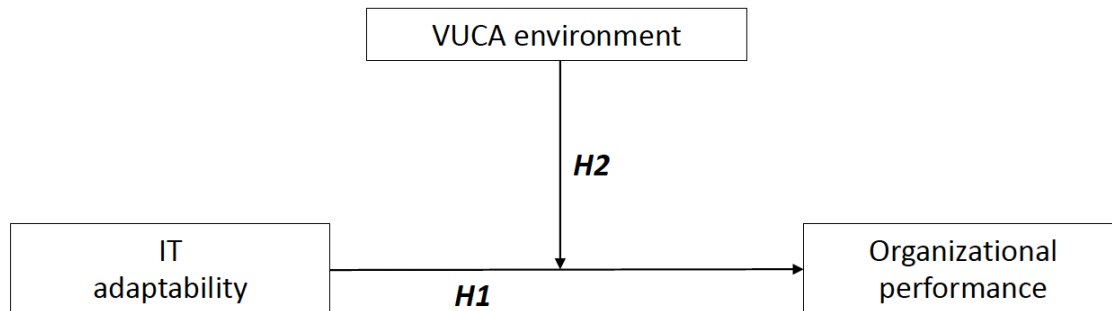
Chen et al., (2014) investigated the influence of agility in business processes, a natural outcome of the VUCA environment, as a moderating factor in the connection between IT capabilities and organizational performance. They demonstrated that an IT-based capability has the potential to yield a favourable effect by fostering adaptable and responsive operations and processes.

Though it seems logical that the VUCA environment might be fostering the role of IT adaptability in organizational performance, Almutairi et al. (2022, p. 744) suppose that it should allow companies to meet industry requirements easily, rapidly and at reasonable cost regardless of the environment dynamics and the duration of the adaptation planning process. Companies should also be aware of the risks of high digital technology diversity, which weakens the role of supply chain learning in operational resilience under VUCA conditions (Liu et al., 2023).

In conclusion, the literature suggests that IT adaptability is of great importance for organizational performance in the current highly dynamic external environment. Adaptable IT plays a pivotal role in enabling organizations to navigate challenging times and maintain their performance through the efficiency and effectiveness of their workforce. Therefore, the following hypothesis can be formulated:

H2: The VUCA environment is strengthening the influence of IT adaptability on organizational performance.

The hypotheses are presented in the Figure 1.



**Figure 1.** Hypotheses development.

Source: own elaboration.

### 3. Research methodology

The proposed theoretical framework was empirically validated through a research project supported by the National Science Center in Poland, under grant No. 2020/37/B/HS4/00130, titled "Development of a Job Performance Model Based on the Dynamic Capabilities of Employees during Various Phases of Organizational Crises." Initially, a pilot study was conducted to assess the efficacy of the research instrument. Subsequently, empirical research was undertaken to test the formulated hypotheses.

The pilot study engaged 25 managers, who served as knowledgeable evaluators. Their valuable feedback was incorporated to enhance the research tool for the primary research phase. Any questions that posed comprehension challenges were rephrased, and measures were taken to mitigate common method bias.

The primary survey was executed during the first quarter of 2021, amid an active wave of the COVID-19 pandemic. It encompassed 1160 organizations operating in Poland, Italy, and the USA. In each organization, a senior-level manager completed a single survey through a procured panel of respondents, and data collection was facilitated using the Computer-Assisted Web Interviewing (CAWI) method. Table 1 presents a breakdown of the sample used in the empirical investigation.

**Table 1.***Sample description*

Country	Not in crisis	In crisis	Total
Poland	83	343	426
USA	95	406	501
Italy	45	188	233
Total	223	937	1160

Source: own elaboration.

**3.1. Variables**

To allow verification of hypotheses the following variables were used: IT adaptability, organizational performance and organizational environment.

IT adaptability: variable assessed on a 5 points' Likert scale (1: I strongly disagree to 5: I strongly agree) using 8 items concerning: support for problems solving, ability to deal with uncertain or unpredictable situations, ease of introducing new tasks, technologies, and procedures, support for various means of communication, ease of infrastructure reconfiguration, handling critical conditions and protocols for emergencies or crisis situations (Tworek, 2023).

Organizational performance: variable assessed on a 5 points' Likert scale (1: I strongly disagree to 5: I strongly agree) using 10 items based on Balances Scorecard concept (Kaplan, Norton, 1996).

Organizational environment: variable assessed on a 5 points' Likert scale (1: I strongly disagree to 5: I strongly agree) using 2 items concerning organizational environment characteristics.

**Table 2.***Variables overview*

Variable	No of items	Alpha Cronbach	AVE (CFA)
Organizational performance	10	0.886	0.494
IT adaptability	8	0.913	0.631
Organizational environment	2	0.843	0.568

Source: own elaboration.

To determine the suitability of the scales for the study, Cronbach's  $\alpha$  and Factor Analysis were conducted and are presented in Table 2. Given that the scales used were previously validated by their creators, this approach appeared adequate. To avoid any potential common method bias, a systematic method variance control was employed. Based on the results obtained, it can be concluded that nearly all of the measurement scales were well-suited, reliable, and internally consistent.

### 3.2. Moderation analysis

In order to verify the proposed hypotheses, the moderation analysis was performed. The influence of IT adaptability on organizational performance was analyzed in the context of organizational environment to verify the statistical significance of it as moderator of the relation. The hypotheses H1 and H2 will be tested using the linear regression model with moderator, testing the following relation: organizational environment as the moderators of the relation between IT adaptability and organizational performance. The regression models were created using the Process Macro for IBM SPSS. The first model was created as a base for comparison, with only independent variable used as predictor. The second model used both the independent variable and the moderator as predictors. The objective was to examine whether the moderating influence was present in the entire sample, considering that the analyzed relation, using model 1. To confirm it, the third model was introduced using moderator as the only predictor. The statistically significant linear regression model with moderator was obtained, where  $F(3,1159) = 51.953$  and  $p < 0.001$ . The results of the analysis are presented in Table 3.

**Table 3.**  
*Regression models' statistics*

Model description	R <sup>2</sup>	Delta R <sup>2</sup>	Moderator coeff.	Standard error	t-stat	p
IT adaptability, Organizational environment, Moderator <i>dependent v.: organizational performance</i>	0.344	0.021	0.115	0.029	5.277	<0.001

Source: own elaboration.

The obtained model was the basis for two conclusions. First, the statistically significant regression model was obtained, which allows to confirm the influence of IT adaptability on organizational performance, which is the basis for accepting H1 hypothesis. Second, the obtained results also show that organizational environment is a statistically significant moderator in case of such relation (coeff. = 0.214;  $p < 0.001$ ). Therefore, the result allow to accept the H2 hypothesis, stating that organizational environment boosts the positive influence of IT adaptability on organizational performance.

## 4. Discussion

The purpose of this study was to examine if the characteristics of the environment are strengthening the influence of IT adaptability on organizational performance. Therefore, the research focused on the aspects that enable organizations to survive and operate on the

market. The construct of organizational performance was taken into account, which is crucial from both a practical and theoretical point of view in the field of broadly understood management. In addition, issues regarding the impact of IT on the organization's activities were considered very important, and in particular the focus was on the IT feature of adaptability. All these analysis were set in the contemporary economic context, taking into account the difficulties resulting from the complexity and turbulent nature of the surrounding reality. The results of the research showed that the more VUCA the environment, the stronger the influence of IT adaptability on organizational performance. The built model is statistically significant and well-fitted.

The above reports seem to be consistent with previous discoveries in this area. The impact of information technologies (in many aspects) on performance seems to be undoubted. Bulchand-Gidumal & Melián-González (2011) noticed that investments in IT can contribute to improved organizational performance, but this is not a direct dependence. Therefore, it seemed advisable to look for variables that could influence this relationship. As a consequence the broadly understood influence of the environment, which is currently referred to as VUCA reality, was included in the considerations. This action seems to be consistent with the approach of Trieu et al. (2023), who have proven that in the case of small and medium-sized enterprises, IT capabilities play a crucial role in shaping company performance in times of crisis. Interestingly, these relationships do not only occur among enterprises, but also among organizations serving society. Fan & Pan (2023) noted that information technology has an influence on e-government performance with the moderating role of environmental uncertainty (which is a part of VUCA environment). And such characteristics of the environment seem to indicate a key role in adapting to upcoming opportunities and threats, so the inclusion of IT adaptability turns out to be justified.

## 5. Summary

The results of the conducted research allowed to establish a statistically significant relationship between IT adaptability and organizational performance. Moreover, the role of VUCA environment as a mediator in this relationship was indicated. This means that the specified research gap has been filled and the assumed goal of this article has been achieved.

The findings from this research can contribute to both theoretical and practical implications. From the development of knowledge in the area of management point of view of, there is the contribution to considerations on enhancement the most important aspect for ensuring business continuity - i.e. organizational performance. Moreover, the research took into account IT issues, in particular a very specific one, important in the context of the need to adapt to turbulent conditions of the internal and external environment - IT adaptability. Finally, those deliberation

were enriched by reports on attempts to describe the still not thoroughly understood VUCA reality. It is also worth emphasizing the importance of this research for business practice. The results may become the basis for creating programs for managers who, in order to protect their organizations against the harmful effects of environmental turmoil, will decide to provide IT systems that will have appropriate characteristics ensuring IT adaptability.

Despite the above implications, the research is burdened with certain limitations. First of all, were made in three (although different on many levels) countries - Poland, Italy and the US. Second of all, the organizations subjected to the survey were selected on the basis of purposive manner. Third of all, the research was conducted in specific conditions - during the active wave of the Covid-19 pandemic. Finally, the model includes only three constructs, and organizational performance is multi - dementional, which may simplify the description of reality. Nevertheless, it can be concluded that the analyzes carried out are a solid step towards increasing the state of knowledge in this area, and it is worth basing further research on this. Therefore, it seems that it would be advisable to conduct research in other countries, make measurements in a representative manner, take into account the characteristics of the industries in which companies operate and expand the list of factors influencing organizational performance.

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## ORGANIZATION OF PASSENGER LOGISTICS PROCESSES IN THE PERSPECTIVE OF EPIDEMIC CONDITIONS FOR AIR TRANSPORT

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**Purpose:** The aim of the research is to analyze changes shaping the organization of passenger service processes in air transport during the epidemic.

**Design/methodology/approach:** The main goal and partial goals resulting from the analyzes performed were achieved by using a developed research methodology that includes literature analysis, analysis of the research area, survey research and process mapping.

**Findings:** The development of research results allowed us to observe differences in the structure of passenger service processes before and during the Covid-19 pandemic.

**Research limitations/implications:** The conducted research was based on a selected representative entity, which is an international airport. Future studies in other ports should be considered to increase the study area and diversify the study population.

**Practical implications:** It is possible to use the developed methodology to standardize passenger service processes in an epidemic situation for various modes of transport.

**Social implications:** Based on the experience of the Covid-19 pandemic, standardization of processes may contribute to improving the quality of services provided and increasing the sense of security of users.

**Originality/value:** The article presents an individual approach to the issues of process designing using the developed research methodology. The work can be used by passenger logistics operators to develop their own passenger service procedures in an epidemic situation.

**Keywords:** process management, air transport, covid-19, process designing.

**Category of the paper:** Research paper.

### 1. Introduction

Management and organization of transport processes is an integral part of the functioning of enterprises on the market. Air transport is the youngest and fastest growing branch of transport in the world. The continuous development of aviation technologies and the implementation of modern solutions in process management are an integral part of improving

procedures and airport infrastructure. Wąsowska (Wąsowska, 2018) states in her work that air transport nowadays is the most important element of global transport infrastructure. It guarantees flexibility and consistency in relation to the changing market environment and is crucial for the functioning of complex supply chains (Brzóska, 2017). Due to the nature of movement, air transport has been the most affected during the Covid-19 pandemic. This resulted in a drastic drop in the number of passengers and thus a reduction in revenues for airlines. While waiting for the vaccine, the authorities of individual countries introduced legal restrictions to reduce air traffic. It has been shown that this branch of transport significantly contributed to the spread of the virus, the subsequent consequence of which was the implementation of a flight ban in the most affected regions (Troyer, Bidaisee, 2022; Tulio et al., 2020). Statistical data published by the International Air Transport Association (IATA) (IATA, 2020) clearly indicate that in April 2020 there was the largest slowdown in air traffic since the end of WWII, where the number of passenger flights was reduced to 6% of the value from 2019. Governments of many countries directed aid through the introduction of relief and support programs due to the significant drop in revenues of the aviation industry by 62%. (Abate, Christidis, Purwanto, 2020; Zhang, Zhang, 2021) Upstream and downstream aviation industries as well as related sectors also saw a significant decline in orders. Many airports were closed, which led to the termination of contracts with aircraft manufacturers, fuel suppliers and service providers. The entire tourism industry based on air connections has slowed down. (Gallego, Font, 2021). The epidemic situation forced the entire aviation industry to look for solutions that would enable it to continue operating on the market. This especially concerned passenger transport, which was drastically reduced. The slow recovery from the pandemic provided greater opportunities for airlines to increase passenger traffic. This was possible, but only while maintaining the necessary safety procedures. (Sun, Zheng, Wandelt, Zhang, 2023). The article analyzes airport procedures from the perspective of a passenger and an airport employee. The research covered one of the largest airports in Poland located in the Silesian Voivodeship. The logistics processes included in the research were narrowed down to a comparative analysis of airport procedures before and during the epidemic state of the Covid-19 pandemic. These analyzes were preceded by surveys, the results of which were presented in the research part.

## 2. Literature review

According to Madeyski et al. (Madeyski, Lissowska, Marzec, 1976) air transport is defined as "the intentional movement of people and cargo in airspace, separated from other activities in technical, organizational and economic terms." The labor resources of air transport include four basic elements, including: airplanes, airports and all devices designed to ensure safe travel,



i.e. precautions and air traffic monitoring (Huderek Glapska, Nowak-Mizgalska, Jankiewicz, Augustyniak, 2019). Aviation law defines an airport as "an airport for public use used for commercial flights" (Art. 2. section 17 Aviation Law, 2023), while an airport is defined as "a separate area on land, water or other surface wholly or partially intended for to perform take-offs, landings and ground movement of aircraft, together with permanent construction facilities and equipment located within its boundaries, entered into the airport register" (Article 2.4 of the Aviation Law, 2023). Nowadays, airports are "complex, large technological and economic organizations" (Stangel, 2014) and fulfill many different functions.

## **2.1. Air transport in the era of the Covid-19 pandemic**

The pandemic has redefined the approach to managing and organizing transport processes. Many works raised the topic of Covid-19 and its impact on individual branches of transport, including air transport, which was one of the most economically disrupted.

Khatib et al. (Khatib, Carvalho, Primavesi, To, Poirier, 2020) identified the risk of virus transmission during commercial flights, referring to the activities of staff and passengers at airports and on aircraft. In the work of Bielecki et al. (Bielecki et al., 2021), the strategy for preventing the spread of the virus in air transport of passengers was reviewed, taking into account: the number of travelers, preventive measures, medical recommendations, visual temperature control, the use of masks and other quarantine measures. Sun et al. (Sun, Wandelt, Zheng, Zhang, 2021) did a great job of reviewing the literature and analyzing over 110 articles in the context of Covid-19 and air transport in 2020.

They explored in-depth issues covered in works related to the global air transport system, the impact of the pandemic on passenger-centric flight experiences, and the far-reaching implications for aviation. Similarly, in the literature research included in the work of Khatib et al. (Khatib, McGuinness, Wilder-Smith, 2021) analyze the role of passenger travel in the spread of Covid-19, the safety of air travel, the effectiveness of control and prevention, and issues related to vaccine passports. Thepchalerm and Ho (Thepchalerm, Ho, 2021) presented a summary of the impact of the pandemic in the context of operational, financial and market impact on airlines.

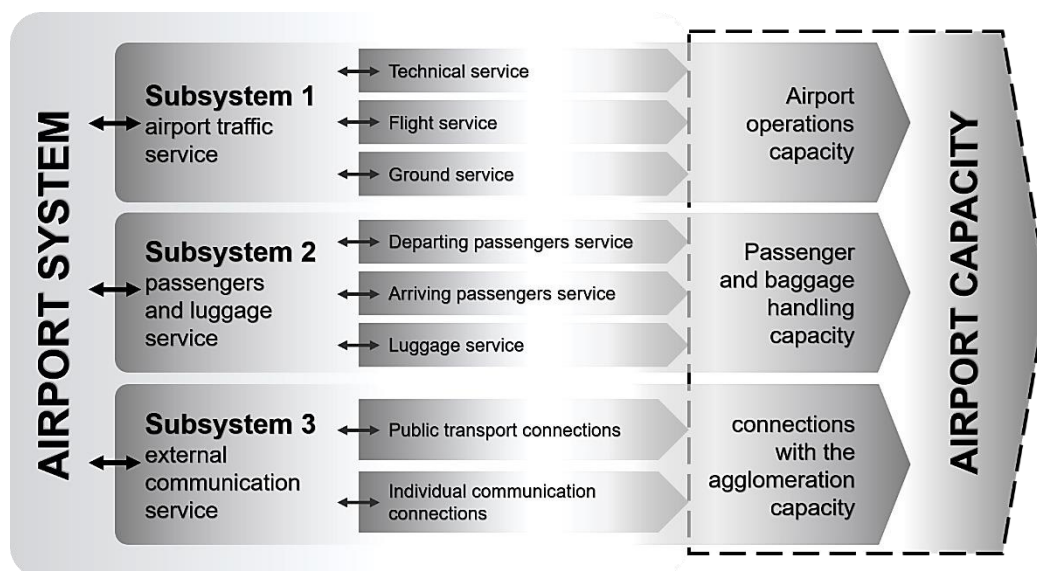
When examining the impact of Covid-19 on air transport, many authors present detailed analyzes that clearly emphasize the importance of the epidemic for the global economy (Agrawal et al., 2023). The biggest collapse of the aviation market occurred in 2020, when in the first half of March the number of travelers on international flights dropped dramatically and a month later there was a 90% drop in the availability of seat kilometers (Suau-Sanchez, Voltes-Dorta, Cugueró-Escofet, 2020; Iacus, Natale, Santamaria, Spyrtos, Vespe, 2020). The capacity of major carriers decreased by approximately 60-80%, and this parameter was most related to the collapse in air travel (Dunford et al., 2020). IATA forecasts included a 55% decline in passenger revenues and a 48% decline in passenger-kilometer revenues. In fact, this decline turned out to be around 66%, which brought back the long-term development of the aviation

market to the state of 1999 (IATA, 2020; 2022). The Covid-19 pandemic wiped out half of airport revenues and two-fifths of passenger traffic in 2020. Airlines reported a net loss of \$5.2 billion in the first quarter of 2020 (First Quarter 2020 U.S. Airline Financial Data, 2020).

## 2.2. Designing passenger logistics processes at airports

The functioning of market entities and industry institutions is inextricably linked to management and process design. Maintaining appropriate internal structures and procedures allows you to efficiently organize the work of enterprises, taking into account appropriate parameters and predicting the results of individual activities. Process design can be defined as activities undertaken as part of the structuring of activities and decisions while maintaining the sequential nature of individual steps (Bendkowski, 2017). However, process modeling allows for accurate mapping of all activities by eliminating possible errors for a smooth and uninterrupted course (Kwasiborska, 2016).

In Będkowski's work (Bendkowski, 2017), the design process is defined as "a substantive and creative type of human activity, emphasizing the creative feature of design that gives the product signs of greater or lesser originality." According to the definition of Hammer and Champy (Hammer, Champy, 1993), a process is "a set of activities that have one or more inputs, which are modified into outputs and then present their value to the buyer." A process is a set of certain activities and events taking place before an obstacle occurs, and the implementation of documents in which a given obstacle is identified and solved is also indicated by Sołtysik (Sołtysik, 2015).



**Figure 1.** Capacity of airport subsystems.

Source: based on Stachlewski, 2011

The global development of air transport and technological development have enabled a rapid increase in demand for air services. A particularly important element during the Covid-19 pandemic was the adaptation of airport procedures to regulations and difficulties in

air traffic (Bitkowska, 2021). Designing logistics processes at the airport is one of the most important activities to ensure the safety of travelers and the stability of the entire passenger transport. An airport is a complex system (Figure 1), it can be divided into several important subsystems: air traffic handling, passenger and baggage handling, and external communication (Merkisz-Guranowska, Kamyszek, Andrzejewska, 2013).

One of the basic modeled processes at an airport is throughput. This is one of the most important parameters aimed at assessing the transport capabilities of a given airport. According to the definition, it is considered that throughput is the value of the maximum operations performed by a given airport, i.e., among others, the number of take-offs and landings reflected in a given time unit (Malarski, Ziółkowski, 2016). Throughput is an important parameter and depends on several factors:

- weather conditions,
- devices aimed at aircraft navigation,
- "landing area" parameters (take-off area),
- flight control instruments (Mascio, Moretti, Piacitelli, 2020).

In accordance with the rules for determining capacity, it is necessary to familiarize yourself with the rules under which a given airport operates. Thanks to such information, an in-depth analysis is carried out, which leads to the closest assessment of the actual throughput. One of the most important processes taking place at airports is passenger service. This is one of the most critical elements of the system and the most dynamic resulting from the need to service several types of groups of passengers and their luggage (Orłowski, Modrzewska, 2020). They can be classified as: arriving, departing or waiting to transfer, the group of the last people are called transfer passengers. Passenger service is a dynamic and time-consuming process that is primarily associated with the thorough preparation of service stations (Sztucki, Gąsior, Zając, Szczelina, 2011). The basic operations that must be performed by a passenger before he boards an aircraft include:

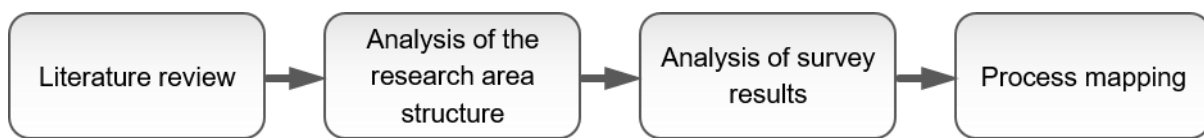
- identification of baggage, appropriate marking for transporting it to the aircraft,
- passenger identity verification,
- issuing appropriate documents enabling the cruise (boarding pass),
- passenger search for security purposes,
- compliance with the trip and indication of the passenger's on-board seat (Załoga, Kwarciański, 2019).

Auxiliary processes at check-in include the use of RFID and baggage identification codes, NFC sensors to shorten check-in activities and systems supporting passenger movement around the terminal. The use of modern technologies significantly improves the flow and acquisition of information in passenger service processes (Zafari, Gkelias, Leung, 2019).

### 3. Research methodology

The main aim of the research is to analyze changes in activities and activities shaping the processes of organizing air transport in epidemic conditions. Additionally, the analyzes carried out are intended to provide answers to questions regarding the impact of COVID-19 on the aviation sector in terms of passenger traffic, as well as issues related to flight safety and the complexity of airport procedures.

First, the structure of passenger air transport in Poland was analyzed based on available statistical data before and after the pandemic. The next stage was survey research, which was conducted in 2023 and included an online questionnaire. The aim of the survey was to indicate the directions of changes in passenger service processes at airports. The sheets contained questions aimed at two separate target groups. The first study was aimed at people traveling by means of transport, such as an aircraft, before and during special pandemic conditions. 155 respondents participated in this study. The second group are airport employees who, as persons staying at airports, directly participated in airport procedures before, during and after the epidemic. The group of respondents consisted of 22 people.



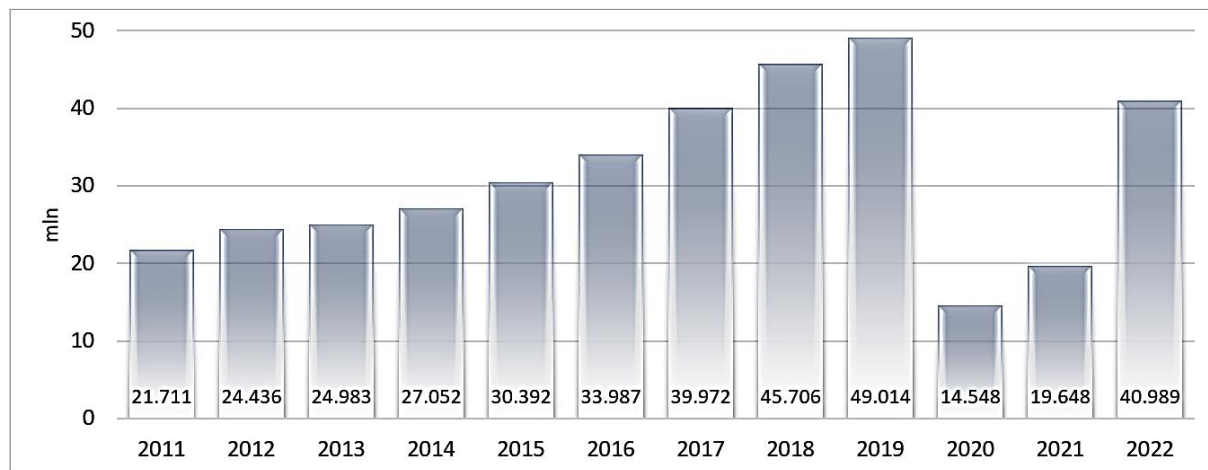
**Figure 2.** Structure of the research part.

Source: own study.

Survey research allowed us to observe key areas of airport operations in the context of changes caused by epidemic regulations. Highlighting the differences in the organization of processes before and during the pandemic guided further activities in the context of developing a process map, and the results of these analyzes were presented in the last research part.

#### 3.1. The structure of air transport in Poland

Transport is of great importance not only in terms of economic aspects for the economy, but also social ones. It is distinguished by a low accident rate; disasters in air transport are rare compared to road transport, which is why it is considered one of the safest forms of transport. According to the statistics of the Civil Aviation Office, in 2019 (ULC, 2020), over 49 million passengers used airport services, which, compared to the previous year, resulted in an increase of over 3 million passengers. The increase was also recorded in the number of flight operations, which amounted to over 400,000, which, compared to 2018, resulted in an increase of almost 5%. The airport in Katowice-Pyrzowice, as one of the key ports in Poland, recorded an increase in passenger traffic by almost half over the years 2012-2019. The greatest increase was recorded at the turn of 2016 and 2017. The upward trend continued until 2019.



**Figure 3.** Quantity of passengers traveling by air in Poland 2011-2022.

Source: [www.ulc.gov.pl](http://www.ulc.gov.pl).

Airports in Poland are located mainly on the outskirts of larger cities, this is due to the area they occupy and the noise generated by air transport, which significantly reduces the level of functioning of society, which is why they are not built in centers. The construction of airports on the outskirts of cities is of particular importance, especially when expanding the aviation infrastructure and the surrounding area, which would be difficult in urban development. Especially if we are talking about the expansion of ports into logistics or distribution parks.

### 3.2. Impact of the Covid-19 pandemic on the aviation sector

The year 2020 will undoubtedly be written in the pages of history - the spreading virus led to a collapse of the economy. The beginning of the economic crisis is considered to be January 30, 2020, when the WHO announced a state of infection threat. The pandemic caused this year by the SARS-CoV-2 virus has changed the current face of the global economy and has had a significant impact on the aviation sector not only in Poland but also across the globe. Which was one of the few transport branches that suffered the most. The Covid-19 epidemic will cause an air transport crisis. Air transport, has so far played an important element of the economic chain and was the most prosperous international branch, and its importance on the global arena was constantly increasing.

The introduction of restrictions caused many problems for airports. Mainly regarding the design of new additional processes and additional safety checks, thanks to which the passenger and the staff reduce the risk of infection. Introducing a number of new processes is a time-consuming cycle, especially in a short period of time. The main processes ensuring reducing the risk of infection with the Covid-19 virus at airports and aircraft included:

- mandatory measurement of body temperature,
- control of wearing masks at airports, but also on aircraft,
- control of presenting a negative Covid-19 test or taking the test at the airport,

- mandatory disinfection,
- limiting the presence of people, including a social distance of 1.5 meters between passengers.

Despite the implementation of all safety rules, there was a visible decline in flight operations compared to previous years, due to the introduction of newer and newer restrictions and long quarantine periods. At the most dramatic moment of the pandemic, this contributed to a complete ban on passenger traffic, as stipulated in the Regulation of the Council of Ministers of March 13, 2020 (Journal of Laws of 2020). The ban did not apply only to persons returning to the territory of the Republic of Poland on the basis of the recommendations of the Prime Minister (Journal of Laws of 2019).

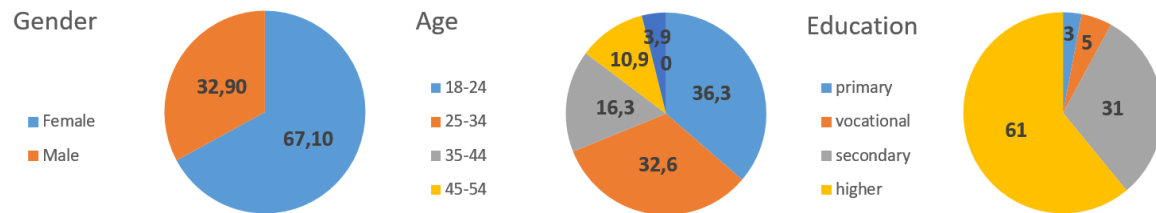
The most dramatic moment of the pandemic for the aviation sector is considered to be April 2020. The air transport crisis ended only at the beginning of June 2020. Air traffic was restored, but it was not completely valid - it was only for domestic connections. Within a dozen or so days of the resumption of domestic traffic, it could also take place internationally, which was not without strict restrictions regarding mandatory quarantine or the presentation of a negative Covid-19 test or, at a later stage, the presentation of a vaccination certificate. Despite the partial resumption of passenger traffic in the summer, this did not allow for significant reconstruction of the aviation infrastructure. This was largely due to another wave of SARS-CoV-2 virus infections. In the following years, i.e. 2021, 2022, there is a clear upward trend in the number of travelers. Forecasts for 2023 are very optimistic. In the first half of the year, airports in Poland served over 23.3 million travelers. This represents an increase of 4.5% compared to the first six months of 2019

## **4. Research results**

The survey questionnaires used during the study were intended for two groups of respondents. In both groups, questions were constructed in relation to the level of participation in airport procedures, separately for passengers and airport employees. Each questionnaire included basic demographics questions and targeted questions.

### **4.1. Survey 1 - passengers**

The largest group of passenger respondents are people aged 18-24 and 25-36, which together constitute 68.9% of all passengers. Most of them were women, as many as 67.1%, and the vast majority had higher or secondary education.



**Figure 4.** Questions about personal details, survey 1 – passengers.

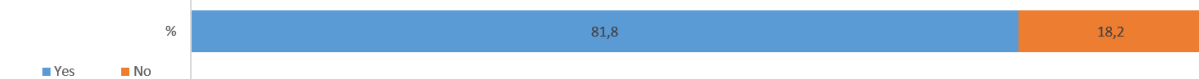
Source: own study.

The next part consists of eight questions and concerned the preferences and behavior of participants using air transport before and during the pandemic.

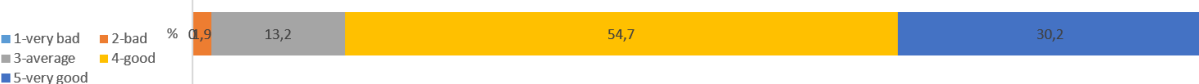
#### 1. Number of flights per year



#### 2. Use of air transport before 2020



#### 3. Assessment of airport procedures before 2020



#### 4. Flight safety assessment before 2020



#### 5. Using air transport during the pandemic



#### 6. Assessment of airport procedures during the pandemic



#### 7. Flight safety assessment during a pandemic



#### 8. Type of travel during the Covid-19 pandemic



**Figure 5.** Structure of responses to the survey 1-passengers.

Source: own study.

In the first question, which concerned the number of flights per year, 63.5% of answers were obtained in the range of 1-2, which means that most respondents limited their trips using this mode of transport to 2 per year. More than 20% declared that they used transport more

often, while 16.1% replied that they did not use it, which resulted in their exclusion from further research.

The second question aimed to identify people who used air transport before the introduction of epidemic restrictions. Confirmation was obtained from 81.8% of people, which qualified them for further participation in the study.

The next two questions were focused on the user's assessment of airport procedures and flight safety in normal conditions. Answers were given on a scale from 1 to 5, where 1 meant the lowest rating (very bad). At this stage, the majority of survey participants rated airport procedures as good (54.7%) and very good (30.2%), which proves high passenger satisfaction and appropriate adaptation of service processes to their requirements. Just over 13% rated the procedures average and only a small number rated them poorly (1.9%). Nobody gave a very bad rating.

In the case of the fourth question regarding safety procedures during the flight, the vast majority rated this stage of the journey as good (47.2%) and very good (45.3%), which in total exceeds 92% of positive answers. The average rating is 5.4% and the negative rating is 2.1%. This distribution of responses clearly indicates a high level of satisfaction with the safety procedures ensured during the flight and proves a high degree of passenger confidence in the staff and pilots. This is the end of the first stage of passenger research, which concerned the period before the pandemic. The answers obtained constitute a reliable basis for stating that airport procedures regarding passenger service and flight safety ensure a high level of satisfaction and flight safety standards among the respondents.

The rest of the research concerns the period when pandemic restrictions were introduced. First, study participants were asked about the use of air transport during the pandemic. A positive response was obtained from 47.2% of respondents, which allowed us to select a group of people for further research.

Questions 6 and 7 are a reflection of previous questions 3 and 4 in the realities of "Covid" restrictions. They concern the assessment of airport procedures and flight safety, where a tendency to change the distribution of responses in a negative direction is clearly visible.

The number of responses rating the procedures as very good (5) dropped by more than half to 14.7%. The number of good ratings decreased slightly, by only 7.6%, which gives a total of 61.8% positive ratings. This is a decrease compared to the period before 2020 by 23.1%. The average rating (3) increased significantly and amounted to 35.3%, which is an increase of 22.1%. Bad ratings are still a small percentage of 2.9%, which together with average ratings gives a result of 38.2% and constitutes a significant increase in "non-positive" ratings.

The structure of answers to question 7, which concerned safety procedures during the flight, shows a similar trend as in the case of question 6. There is a clear difference between the increase in "non-positive" ratings (1,2,3), which constitute a total of 44.2%. This gives a 36.7% jump compared to the pre-pandemic period. This clearly indicates a reduced sense of safety

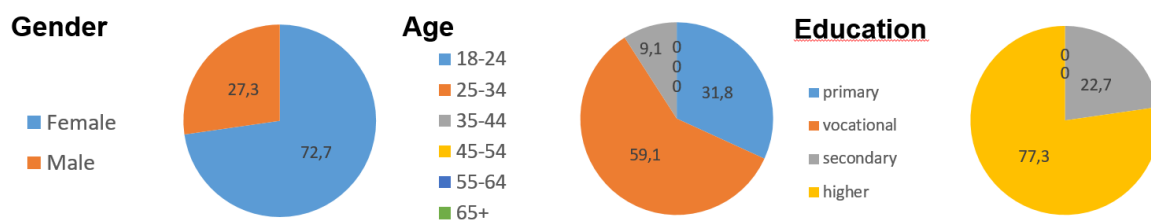


among passengers, which was most likely caused by a number of regulations hindering travel comfort and the awareness of the possibility of endangering health.

The last question concerned the type of travel during the pandemic. It did not have a significant impact on further research, but was included to highlight people's social behavior. Among people who traveled by air during the pandemic, as many as 70.6% traveled for private purposes. This does not mean, however, that they were not necessary and justified. Part of the society consciously declared a lack of interest in Covid-19 topics and downplayed some of the restrictions. Travel for professional purposes certainly has a higher justification status, but with such a significant reduction in all flights during this period, this number is not significant.

#### 4.2. Survey 2- airport employees

The airport employees participating in the study constituted a group of 22 people. This study was carried out using an electronic spreadsheet and face-to-face interviews with a paper spreadsheet.

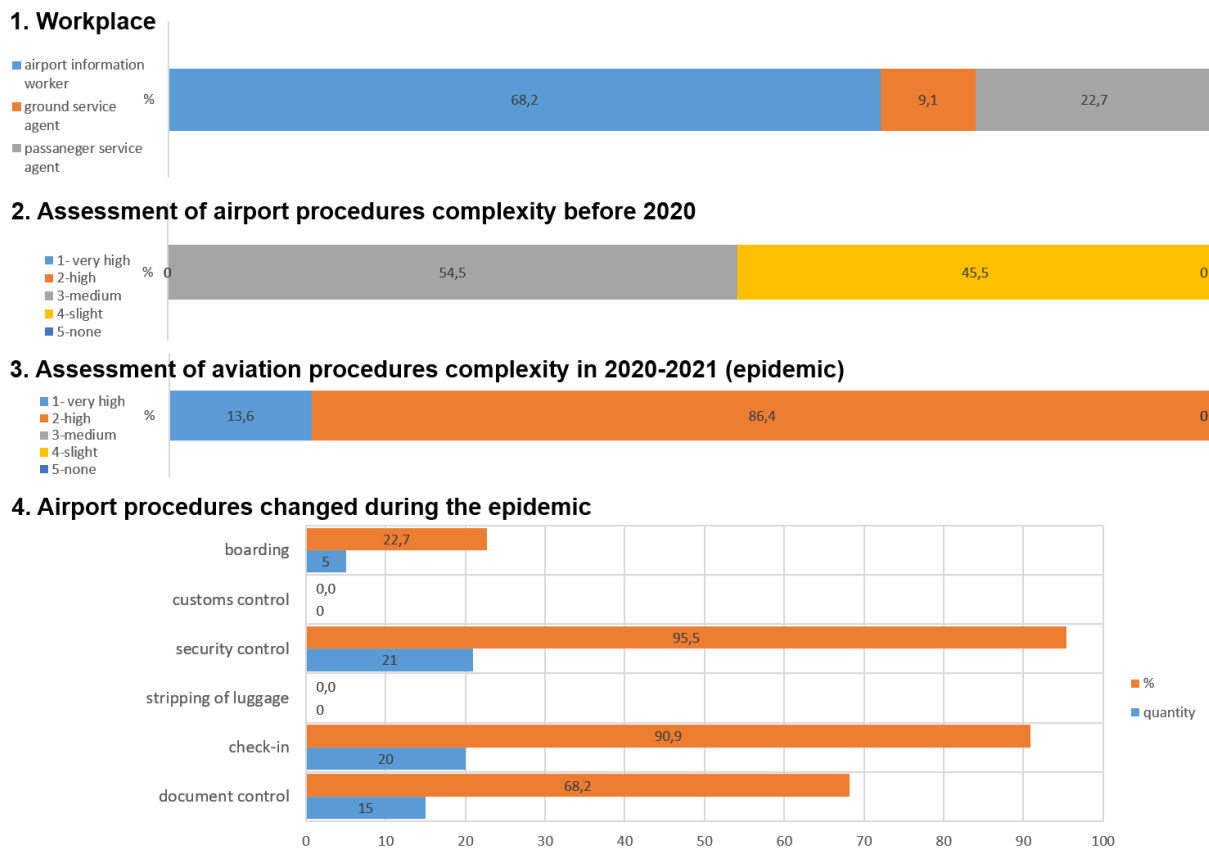


**Figure 6.** Questions about personal details, survey 2 - airport employees.

Source: own study.

Women constitute a significant group of employees, as many as 72.7%, which may be related to the job position held by the respondents. The age of the respondents also proves their experience in the labor market, not only in airports. Less than 60% of employees are aged 25-34, while 31.8% are aged 18-24. This clearly indicates a very young workforce. Only 9.1% of people declared their age to be between 35-44. No other answers were received, which means that people older than 44 may be employed in other positions. The survey was conducted among employees actively involved in passenger service processes, which to some extent excluded management staff from the research sample. Most people have higher education, this is a group of 77.3%, the rest declared secondary education. There were no answers regarding primary and vocational education.

A survey was conducted among airport employees, the results are presented in the figure above. It included a questionnaire consisting of four questions, the first three being single-choice questions and the fourth being a multiple-choice question.



**Figure 7.** Structure of responses to the survey 2 - airport employees.

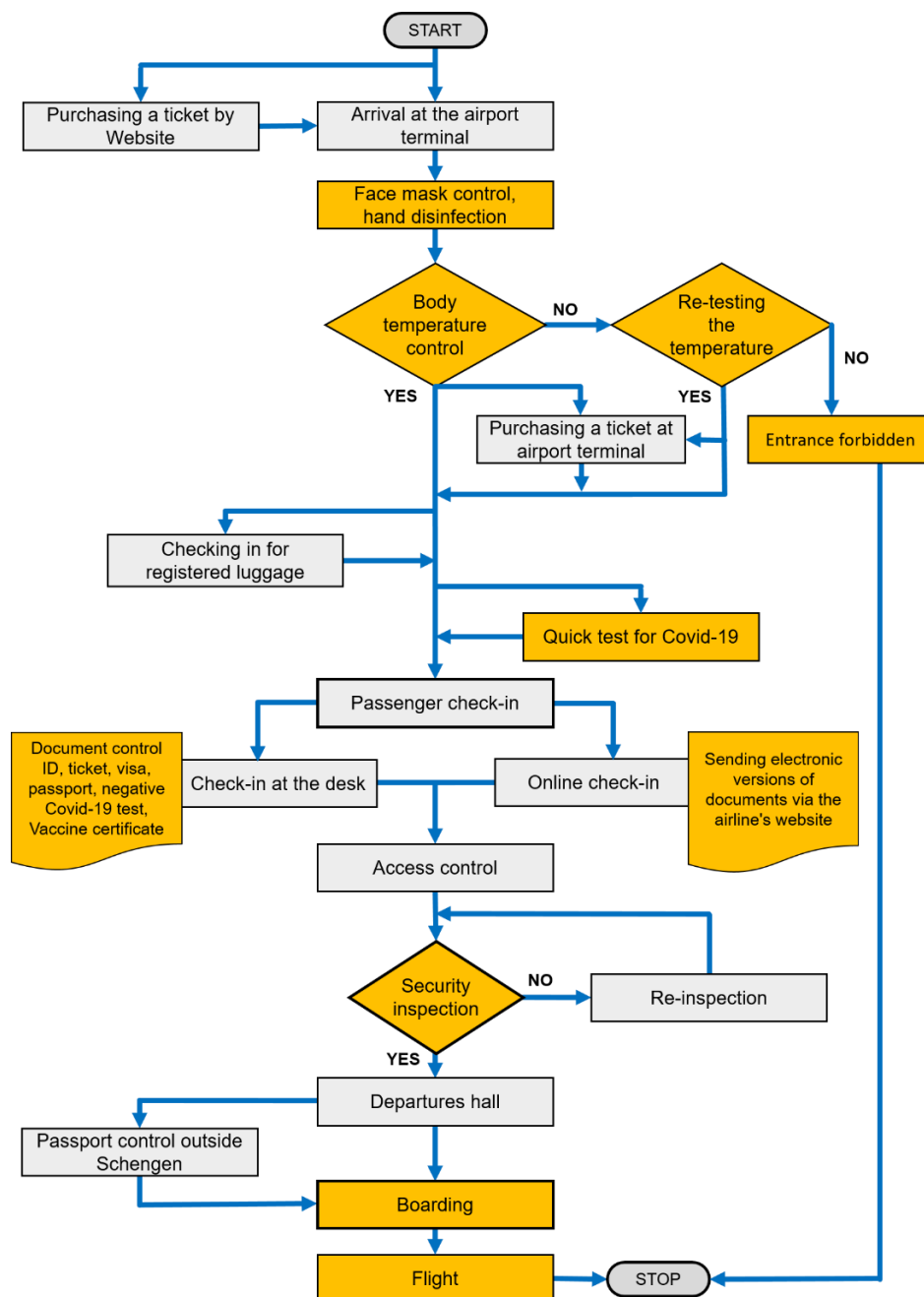
Source: own study.

The first question concerned the job position. Among the respondents, 68.2% were airport information workers and 22.7% were passenger service agents. The rest are ground handling agents. Two questions were intended to indicate differences in the organization of airport processes resulting from changes in regulations during the pandemic from the employee's point of view. The degree of complexity of the procedures was assessed on a five-point scale, where 1 - very high - meant the worst result. Airport employees indicated that before the pandemic, the level of complexity of passenger service procedures was medium (3-54.5%) and low (4-45.5%). No other answers were received. It can be concluded that the moderate evaluation of employees is due to good training and low complexity of the procedures themselves. In the symmetric question about procedures during the pandemic, the results turned out to be completely different. Respondents rated the level of complexity as very high and high, which indicates drastic changes caused by the restrictions. This is primarily related to adapting procedures to epidemic regulations regarding the safety of travelers and staff as well as preventing the spread of the virus.

The answers obtained in both surveys constitute the basis for developing a map of the passenger service process, taking into account the stages introduced during the pandemic.

### 4.3. Mapping passenger service processes in air transport

According to statistics, air transport is the safest branch of transport. Ensuring this state is associated with a very precise and demanding level of management of airport processes, which must meet all safety requirements. Process management, in turn, involves their proper design and mapping. A number of activities are undertaken to efficiently guide the passenger through all stages of the process, from arriving at the terminal to boarding the plane. Airport procedures for passenger service are presented in Figure 7. The process is presented in the form of a map illustrating individual stages of the passenger's path to the plane, including changes marked in orange color. These are operations and activities that appeared or changed during the pandemic.



**Figure 8.** Passenger service procedure during the Covid-19 pandemic.

Source: own study.

The whole process begins with purchasing a ticket, which can be done in two ways. The most common method is purchasing via the website. The next step was to measure the body temperature of a person entering the airport terminal. This activity is marked as new introduced during the pandemic. In most cases, this was done using thermal imaging cameras or other measurement methods. Only people whose body temperature was within normal limits were allowed to enter the airport. Covering the mouth and nose with protective masks was also mandatory when staying at the airport. Moreover, each person staying in the terminal was asked to disinfect their hands using special dispensers, mainly automatic ones, with disinfectant liquid, which were located in designated places.

A key and necessary step for every passenger is check-in. In the case of a standard procedure, after arriving at the appropriate desk, an airport employee checks the passenger's identity (checking documents: ID card, visa, passport, etc.). At this stage, the passenger receives a boarding pass that contains the most important information about the flight. Online check-in is carried out entirely by the passenger using forms on the websites of the airlines. It must be done within the previously designated time frame. After thorough verification of the documents by the staff, a boarding pass is generated, which the passenger should have with him in paper or digital form. The changes introduced in the clearance process consisted primarily in additional documentation. Among other things, in addition to the basic documents, the traveler had to present a negative Covid-19 test or an EU Covid Certificate depending on which country he traveled to and what safety rules were in force in a given country. Rapid direct tests could be performed at designated airport locations. Additionally, the passenger had to submit health documents by completing a form regarding potential contact with an infected person or any disturbing symptoms occurring in recent days.

Access control involves verification and scanning of the boarding pass at automatic gates leading to further control.

The security check is one of the most important stages, the aim of which is to exclude any potential danger caused by the human factor (passenger). In this procedure, passengers are subject to inspection of the contents of their luggage, i.e. compliance with the requirements established by the airlines and whether their hand luggage meets the dimensions and weight requirements. The luggage is x-rayed using scanners, thanks to which the inspector verifies its contents. The passenger is also subject to inspection, passing through a special gate detecting metal elements that could pose a threat to other flight participants. There are also additional forms of personal inspection that are performed on random passengers or people who have been detected with irregularities. During this search, the passenger is again subjected to a more thorough inspection using a hand-held scanner.

After passing the security check, the passenger goes to the departures hall, where he waits for his flight. The last stage is boarding. In the case of passengers traveling outside the Schengen area, additional passport verification is performed. Before boarding the aircraft, you must show your ID and boarding pass. After positive verification of documents, passengers go to special

passages (communication routes) facilitating boarding the aircraft or are directed to vehicles that will safely transport them close to the aircraft. During the pandemic, entry methods may have varied slightly by airline. However, in order to limit the transmission of the virus, in addition to maintaining social distance, passengers boarded in the order in which they took their seats. The first passengers from the back of the plane and subsequent passengers. Changes were also visible in the procedures in force on the plane. This included a reduction in the number of staff and passenger-staff interactions as well as a reduction in on-board catering services.

## 5. Summary

There is a huge number of studies in the literature relating to the impact of the pandemic on individual economic, social and environmental aspects. The Covid-19 pandemic has had a huge impact on the global economy. Passenger air transport, as one of the main economic sectors, was also subject to turbulence related to the crisis in global logistics. Legal regulations limiting the intensity of virus transmission particularly affected passenger transport, and aviation was one of the main channels of its spreading. Many works raise the issue of the collapse of this branch of transport, seeking explanations for the situation and analyzing the effects in the studied areas. The research methodology presented in the work is characterized by four main stages.

First, a review of the literature on air transport in the era of the pandemic was performed. This is an introduction and reinforces the need for further research focusing on aspects of process management.

The second stage included the analysis of the research area. The aim of the activities undertaken in this regard was to structure knowledge and statistical data on passenger air transport. The directions of changes taking place in the development of passenger aviation under the influence of the pandemic were demonstrated, as well as an analysis of the economic factors resulting from the appearance of the virus.

Then, the results of survey research conducted to identify changes in passenger service processes that were introduced during the pandemic were analyzed. These studies were conducted on two groups of respondents representing "users" and "providers" of given services. This differentiation was intended to indicate relationships that are emphasized by separate groups of people participating in the same processes from a different perspective. This allowed us to identify in detail the stages of the passenger service process that were introduced as procedures to increase the safety of airport users and employees.

The last part of the research involved creating a map of the passenger service process. The aim of the actions taken was to indicate in detail the occurrence of new or changed process activities and to present them in a graphical form. The visualization of the process clearly highlights the number and complexity of airport procedures that have been introduced to protect travelers. It also summarizes all stages of the research. In retrospect, we can see how sensitive and prone to crises the current global economy is. It is a complex structure, composed of many interconnected elements that constantly change and interact with each other. The presented research results present a certain perspective on the possibility of their future application as a model for reorganizing processes in an epidemic situation. Similar crises will probably occur on different scales and at indefinite intervals, so it is important to draw conclusions from experience and develop corrective actions for the future.

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## DIGITAL SKILLS IN END CLIENTS IN THE CONTEXT OF TECHNOLOGICAL DEVELOPMENT OF INSURANCE COMPANIES

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**Purpose:** There is a large gap between the digital skills of customers and technological advancement in insurance. The author assumes that in countries with low level of digital skills the interest in insurance is also low. Technological achievements are used by insurance companies (e.g. to estimate the costs of war) and by clients themselves (e.g. AI to analyse ECG test results). However, the development and creation of new solutions give rise to a question whether the end client can keep the pace with such quick changes. The main objective of this article is to establish a link between household finances and technological development of insurance industry. The author wants to analyse household income, spending and money assigned for insurance premium payments from the perspective of a household. The other objective of article is to study insurance companies' interests in education and development of digital skills.

**Methodology:** The article uses a critical analysis of literature, statistical inference method, observation method and market research.

**Findings:** The research conducted proves that in the case of the relationship between insurance and household finances, "ground work" needs to be done. This means that it is not enough for insurance companies to implement another technological innovation. Research shows that in addition to digital skills, financial knowledge should be supported. Without financial and insurance knowledge in households, even the best innovations will not increase financial awareness.

**Research limitations/implications:** This article makes a good starting point and inspiration for further considerations in the area of digital skills and the approach of insurance companies to implementing innovations. Further academic work and practical analysis in insurance companies should attempt to point to the future direction: whether new innovative solutions should be made available for a smaller group of clients (with higher digital skills) or should less innovative products and services be available for a wider audience? Further considerations are needed from the perspective of the end client, regarding the readiness of insurance markets in particular countries to introduce InsurTech solutions. It is also crucial to study further the topic of household priorities regarding spending categories, and including insurance spending. It is also worth taking a look at issues related to innovation maturity, the level of sales of particular products, and then comparing that data to the level of financial knowledge and the level of digital skills.

**Practical implications:** This study recommends insurance companies to implement actions to avoid digital exclusion as part of their attempts to raise the level of innovativeness. Various developmental and inclusive programmes should be carried out not only by governmental institutions and non-governmental organizations but also by service providers (here: insurance providers).

**Keywords:** digital skills, insurance, customer, fintech, household.

**Category of the paper:** market research or surveys, empirical, scientific.

## 1. Introduction

The Infuture Institute's map of trends (2022) shows that from the perspective of a household and business insurance digital inequality is a very important trend that requires attention. This is in fact a leading trend that involves problems with access to the global network and digital exclusion. According to data, 40% of global population still has no access to the Internet and the steady inflow of new digital solutions can make this problem even worse. It is also worth considering that new trends have appeared, namely an anti-science trend (an approach where science is no longer believed to be an objective, universal base for the functioning of the society) as well as anti-tech trend (a resistance against big technological companies and their influence on the lives of individuals and the whole society; anti-tech approach also includes more mindful use of technologies or total abandonment of excessive presence of technologies in individual's life). Both these trends are included in the so-called 'reactive zone', which means they need less than 5 years to become leading trends. This allows to conclude that the bold arrival of new digital technologies in the insurance industry is on the one hand a big opportunity for clients but on the other it can simultaneously pose a threat to them. It is similar for insurance companies themselves. The sale of insurance products through modern distribution channels is on the rise. However, the direct contact between the end client and the insurer is still indispensable. According to the European Economic and Social Committee (2017) the digitalization of financial industry, including insurance, creates a lot of opportunities, such as easier access to financial products and services, opportunity to compare prices, and customization of products to fit individual needs of clients. At the same time, however, the threats include possible security breaches, unregulated areas (such as cybersecurity), creation of products too complex, technological problems with the delivery of full information about products, and digital exclusion. More and more insurance providers cooperate with InsurTech industry. Many other companies also operate on the market as InsurTech industry. It is vital to start a series of actions in the area of financial education and upgrade digital skills in all actors that participate in insurance processes (i.e. all activities related to insurance, purchase, withdrawal, payments, damage claims, designating beneficiaries and others).

## 2. Literature Review

Households are the most numerous elements of the economy and their role in social and economic development of the country still grows (Grzega, 2022). There are many definitions of this entity. Some authors say living together is a necessary element (Beaman, Dillon, 2012), others mention the need to jointly manage shared assets (Bywalec, 2017) or no need to be related (GUS, 2022). In the subject literature a household is also often used as equal to a family. However, this term is often multi-layered and difficult to define, and the same is true for the term ‘family’. Examples of difficulties include the following situations: a registered marriage of a couple who live separately; two people (regardless of their sex) who live together but are not married or two people who are regular partners (again, regardless of their sex) but do not live together and are not married (Rozentāle, 2021). Finance-related decisions taken by households can be divided into four groups:

- decisions regarding savings,
- decisions regarding loans,
- decisions regarding investments,
- decisions regarding consumption,

The question arises here: to which group do decisions regarding insurance belong? In order to answer it is best to turn to the theory of economy. Decisions taken by an individual are determined by their needs. Insurance is akin to the need of security, the second-tier need identified by Maslov (1954). The decision to purchase insurance is also influenced by the level of everyday spending and the prognosis of spending in the future. In this context we should consider the life-cycle hypothesis (Modigliani, 1975; Yaari, 1965). The theory of permanent income (Friedman, 1957) and behavioural theory (Müller, Tietzel, 2002) also refer to setting aside consumption for a later period. The above mentioned definitions allow to conclude that the insurance-related decisions are closest in nature to decisions regarding savings (deferring current consumption) and theories related to savings. Second option regarding the classification of insurance purchase decisions is that decisions regarding insurance should be treated as a separate category of financial decisions. Motifs behind decisions regarding insurance are also important. In the subject literature more and more popular is an approach in which end clients decide to purchase insurance because of reasons other than risk aversion. Risk aversion is more of a special factor than a general rule (Fels, 2021). Households show a range of other motifs behind the decision to buy insurance. Author’s own research indicates 5 most important factors influencing decisions regarding insurance, including: the scope of insurance, price, and trust in insurance provider. It is interesting that in the digital age the possibility to buy insurance online is not indicated as an important factor determining the purchase and that a face-to-face meeting with the insurance agent was indicated as the most preferred form of purchasing insurance (while mobile apps were the least preferred options) (Samsel, 2022). This is, however, what the

situation looks like from the perspective of the client. On the other side there are insurance companies, progressing technological development, implemented innovations in services and products and a strong growth of InsurTech sector (Volsovykh, Zelenitsa, Kondratenko, Szymła, Mamchur, 2021). Initially, InsurTech companies were focused mainly on property insurance, accident insurance and distribution. Distribution, sale and various price checker start-ups were very popular. Nowadays, InsurTech solutions can be found in every area of broadly understood insurance ecosystem. Traditional solutions are also supported, as well as their transition and adjustment to the digital reality. In the future, further digitalization is expected as well as more innovative products. These actions are meant to boost demand for additional, more niche insurance products and services (Ostertag, Morvan, Metzger, Levy, 2022). Having said that, it will be good now to turn back to households and their abilities to use modern technologies. European Parliament considers digital skills as one of the fundamentals abilities in contemporary humans (alongside literacy, numeracy and math and language skills). The so-called Digital Competence Framework for Citizens (DigComp) gives a definition of digital competences as ‘the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society’. It is a combination of knowledge, skills and approaches (Vuorikari, Kluzer, Punie, 2022). Covid-19 pandemic was a turning point for households that triggered a deep verification of digital skills and competences. According to the study carried out for digital education action plan, more than one-third of 13 and 14 year-olds who participated in the study did not even have a basic level of digital skills. Every second household with low income has no broadband access (European Commission, 2018).

### **3. Materials & Methods**

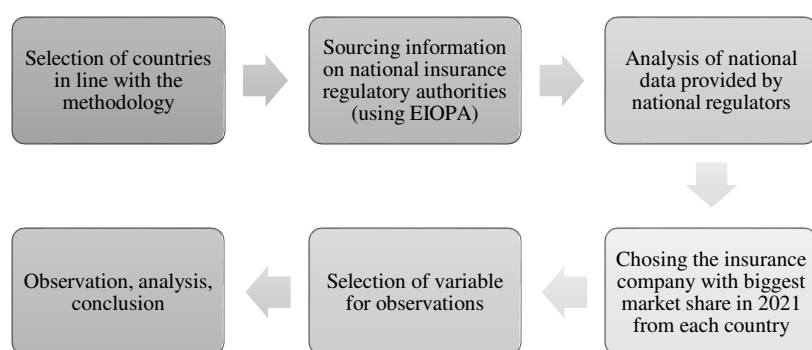
In line with the principles presented in Nature Nanotechnology: ‘Data are the foundation of scientific progress’ (Nature Nanotechnology, 2020). Taking this right thesis into account, in this article the author uses the most recent data available. What is more, the author uses data from official sources, available to every person who would like to get an insight into their knowledge and use the data for own further studies.

In this article the author used many methods of academic research. The author started with critical literature review, which was already presented above under the subtitle ‘literature review’. Additionally for the purpose of this article, the author used document analysis and logical and constructive analysis. This allowed a methodological progress from specific to general, which led to a logical and syntactic linkage of small units, such as households, with big, modern units such as InsurTech entities.

Statistical method was useful to draw conclusions from the analysis. Heuristic method was also used. All of those methods were meant to verify the assumed research hypothesis and achieve the set objectives.

As indicated, when using inductive method the first step was to choose countries appropriate for this study. The choice of countries was based on household insurance spending in selected countries in Europe in 2019 (Statista, 2022) to bring together the approach of households and spending on insurance. The countries were divided into 5 groups (quintiles) in line with the methodology of household budget research (GUS, 2021). In the next stage one ‘representative’, a leader of each group, was chosen from each quintile. Additionally, alongside the objective approach (the quintiles) the author added a subjective approach. The latter determined a choice of Poland, where the author lives, and Estonia, which was the last country in the ranking. Poland had the 3<sup>rd</sup> place in the second quintile. This approach allowed to choose the following countries for further study: France, Belgium, Sweden, Slovakia, Lithuania, Poland and Estonia.

A choice of insurance companies from each of the above mentioned countries was presented for the study. The procedure followed the methodology presented in figure 1. Research included the observation based on a set of variables in each chosen insurance company.



**Figure 1.** Selection process of insurance companies for this study.

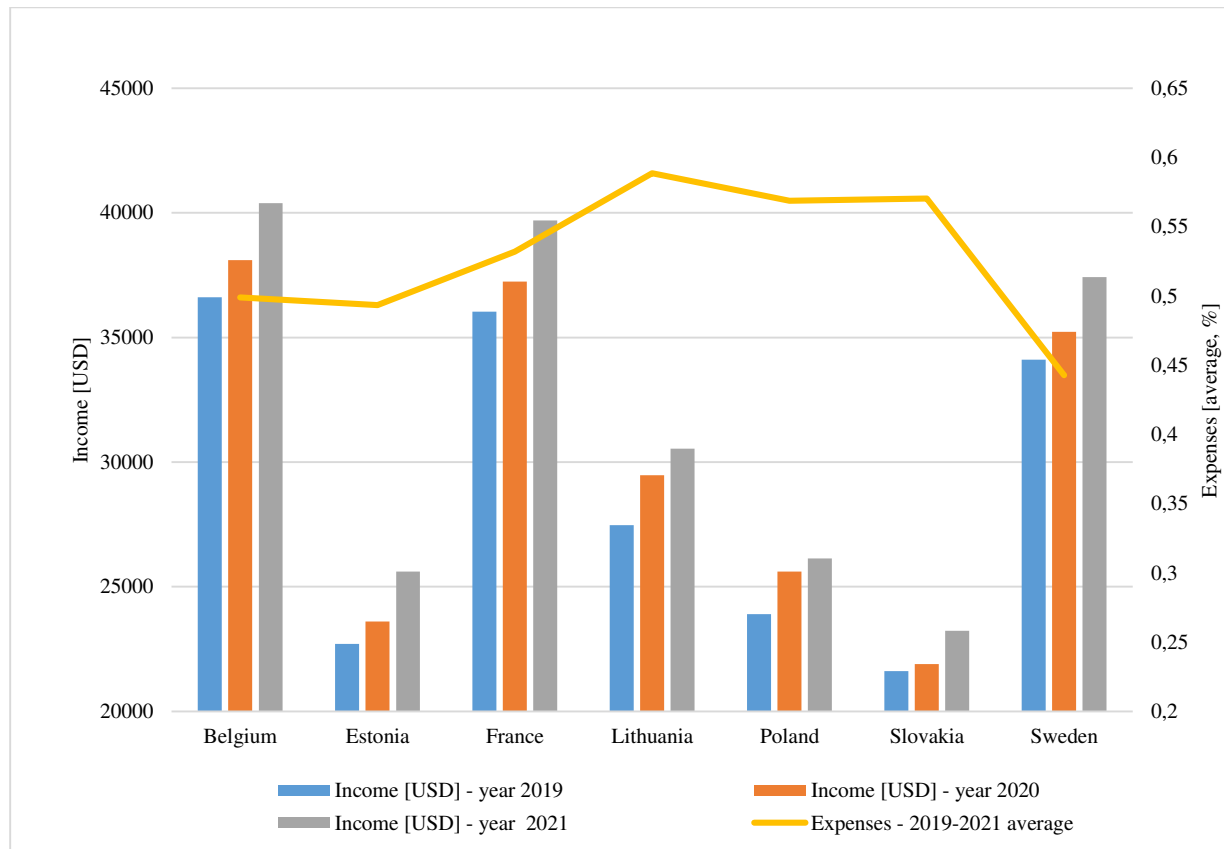
Source: Author's own work.

Detailed analysis based on the assumed methodics and methodology is presented in the following subchapter.

## 4. Results

In recent years it was Belgium that had the highest levels of spending among the selected countries. Household disposable income is presented at its pre-tax level (including social transfers) (OECD, 2022). The value is presented in US dollars per resident in a particular year. Belgium has the highest income, whereas Slovakia has the lowest. It is worth noticing that none of the studied countries has recorded a fall in the level of income during the analysed period. The rate of growth has a decreasing tendency: the average rate of household disposable income

growth in 2021 (against 2021) was 5.58% and was 1.24 percentage points higher than in 2020 (against 2019). The diagram also presented household spending (as a percentage of country's GDP). The diagram assumes an average value for 2019-2021. It is interesting that in each period, when analysed separately, the household spending in each country (excluding Slovakia) is higher and has a decreasing tendency. Regarding averages, Lithuania has the lowest level of household spending, whereas Sweden has the highest.

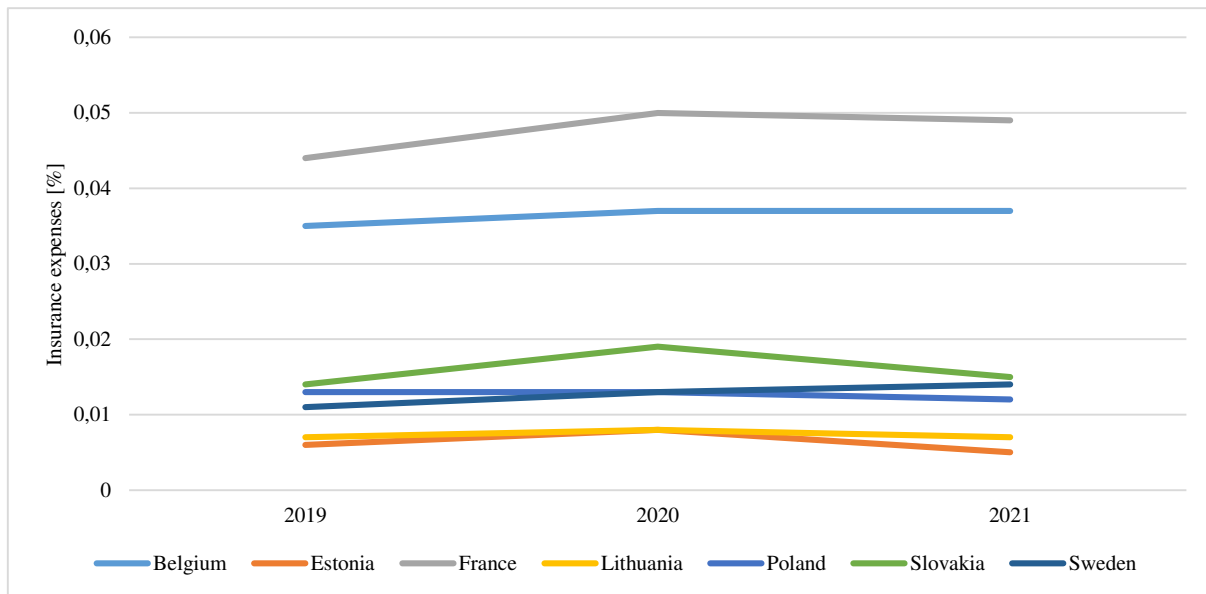


**Figure 1.** Household income and spending in selected countries in Europe.

Source: Author's own work.

When talking about household spending it is worth noticing the level of insurance spending. Figure 2 shows a cross-section of the level of insurance spending in particular countries. The residents of France spend the most on business insurance. Also Belgium and Slovakia have a high level of insurance spending. The lowest level is observed in Estonia and Lithuania. It is worth noticing that in each country, except for Sweden, a percentage share of insurance spending in overall spending was the highest in 2020.





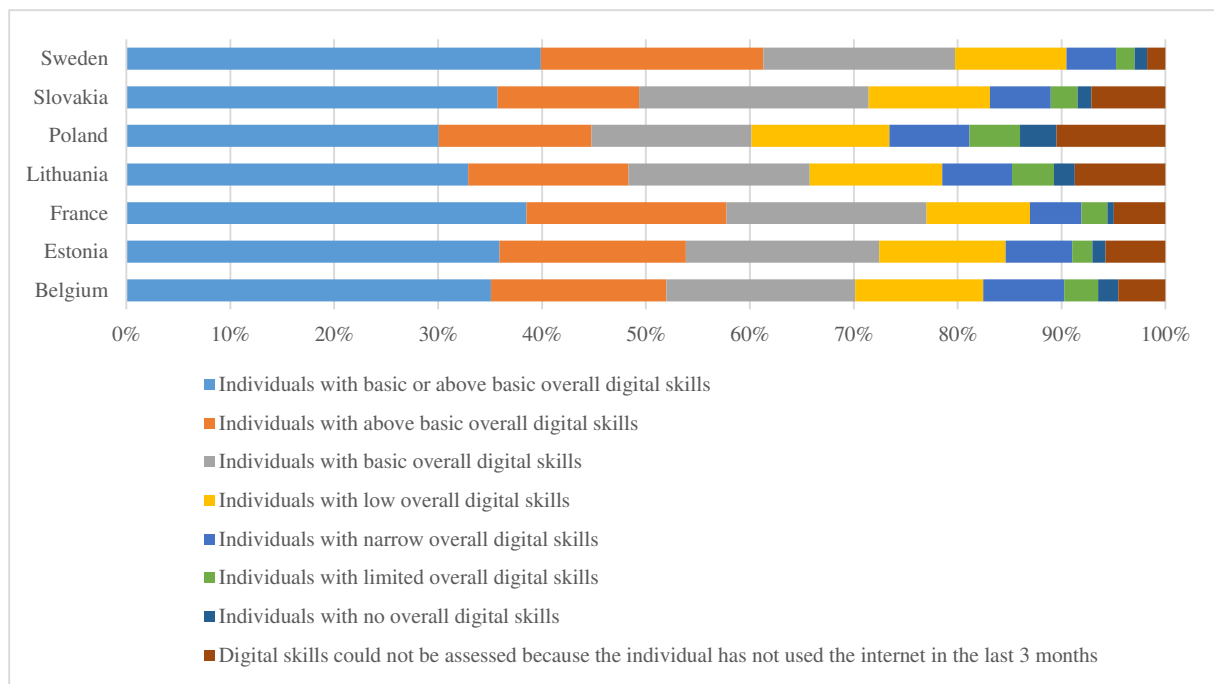
**Figure 2.** Share of insurance spending.

Source: Author's own work.

While talking about household spending it must be noticed that in analysed countries the level of spending on cloths is higher than on modern technologies (mobile phones, telephone services, and audio and visual devices to process information). In 2019-2021, the average value of clothes spending was higher than 3.5% (with a raising tendency) while the average value of technological spending was about 1.35% (with a decreasing tendency).

Some may ask why paying attention to other types of spending when considering insurance spending. The answer is that while considering how much households spend on insurance, it is good to compare it to spending on, for example, clothes or IT devices. Access to such equipment that allow to develop digital skills is crucial for the functioning of a household as a client on insurance market. Without goods and services (telephone, computer, internet) and constantly upgraded digital skills to catch up with developing markets (including insurance) a household would lose the ability to be an active participant on the insurance market and play the role of digital end client.

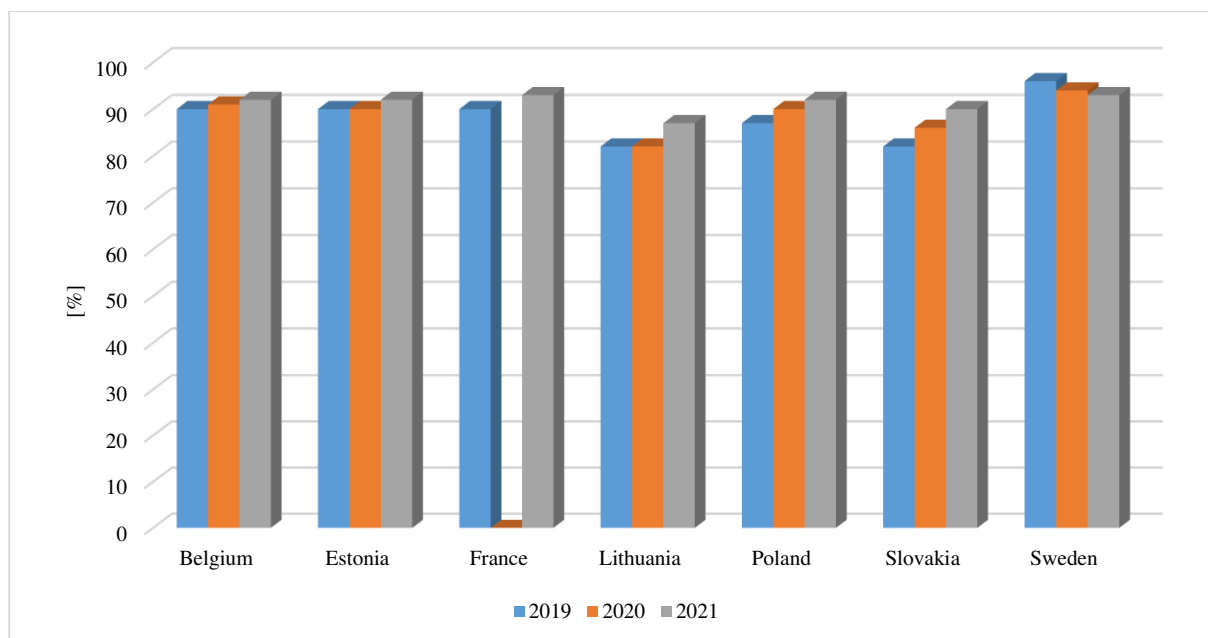
Figure 3 shows the level of digital skills of residents in selected countries in 2021. In each of them the biggest number of people have either basic or above basic overall digital skills. The biggest number was noted in Sweden. In Slovakia the number of people with basic overall digital skills is higher than the rate of people with overall digital skills (Slovakia is the only country in the analysed group with such a relation). Poland is also an interesting case. The obtained results show that there is much more people without overall digital skills than in other analysed countries. It is also characteristic for Poland that it is often impossible to asses digital skills due to the lack of use of Internet in the last three months. This rate is the highest in Poland in comparison to other analysed countries.



**Figure 3.** Digital skills of residents in countries in Europe.

Source: Author's own work.

When talking about digital skills it is also important to study the level of Internet access in analysed countries. For 2021, the average level of access in all studied cases was 91%, with France and Sweden recording the highest rate (93%) and Lithuania with the lowest one (87%). In all analysed countries (except for Sweden) there is an increasing tendency. It must be pointed out that there was no data available for France for 2020.



**Figure 4.** Internet access in countries in Europe.

Source: Author's own work.

For the purpose of this article the author carried out observations of selected insurance companies regarding the access to digital solutions. The results of the analysis are presented in Table 1.

**Table 1.**

*Analysis of digital services in insurance companies in Europe.*

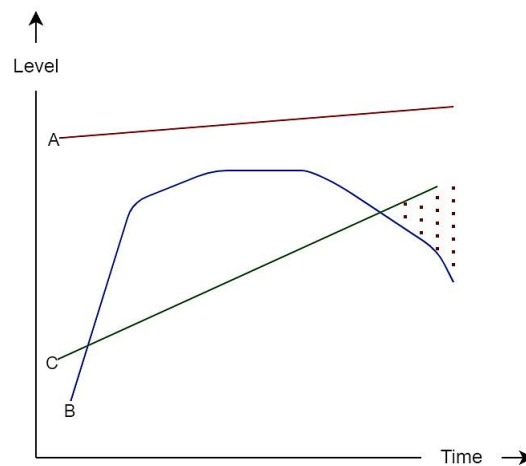
Country	Insurance company	Web site	Mobile app	Client's portal / online purchase	Online claim	Online payments	Modern solutions
<b>Belgium</b>	AG Insurance	+	+ / - (only for travel insurance)	-	-	+	+ (examples: chat-bot, online expert's opinions)
<b>Estonia</b>	If P&C Insurance	+	+	-	+	+	No data
<b>France</b>	Crédit Agricole Assurances	+	-	+ / - (website available for the clients of the bank – joint service)	-	No data	No data
<b>Lithuania</b>	AB Lietuvos draudimas	+	-	+	+	+	No data
<b>Poland</b>	PZU	+	+ / - (limited chances to purchase insurance)	+	+	+	+ (example: AI to interpret ECG test results)
<b>Slovakia</b>	Allianz - Slovenská poisťovňa	+	+	+	+	+	+ (example: quick quote, abandoning of paper; signing digital contracts)
<b>Sweden</b>	Länsförsäkringar	+	+	-	+	+	No data

Source: Author's own work.

The analysed data allow to conclude that the selected insurance companies from Poland and Slovakia have the highest level of innovativeness. Insurance companies from Sweden and Estonia do not have a client's portal and do not publish data related to implementation of modern solutions or cooperation with the InsurTech sector. These countries have a medium level of innovativeness available for clients. Based on Table 1 it can be concluded that France and Belgium have the lowest level of innovativeness.

Taking into consideration these results as well as earlier considerations regarding digital skills, it can be said that innovations available are inversely related to digital competences. Countries described as highly innovative in terms of available solutions have a relatively low level of digital skills (Poland, Slovakia). The opposite can be said about countries with the highest level of digital skills. Simultaneously the analysis suggests that they have quite a low level of innovative solutions (France, Belgium). It is also interesting that the countries with low level of innovativeness available for clients also have the highest level of insurance spending.

The model below summarizes the above conclusions.



**Figure 2.** Model of dependencies between digital skills and the development of modern technologies.

Source: Author's own work.

The above model was developed based on the following variables: time and level. Letter A stands for the level of Internet access while letter B stands for the change in digital competences in time – throughout the life of an individual, Letter C then stand for the increase in innovativeness in the insurance sector. The more numerous and the more complex technological solutions are available for households, the higher should be the level of digital skills (to make it possible to make a full use of all available solutions). The enclosed area between lines B and C indicates the optimum match in terms of skills needed to use the innovations in insurance. The area beyond those variables marked with stripes indicates the gap that makes it impossible to adjust to innovative conditions on the market.

## 5. Discussion

The analysis allows to conclude that the development and growth of digital skills does not go hand in hand with the availability of innovative insurance products and services. Fels is therefore right to say that risk aversion is currently not the most important factor that influences decisions related to the purchase of insurance. It also confirms author's own research that traditional communication channels with the insurance provider are more popular among households than the innovative ones. The authors who indicate the InsurTech is developing and that insurance companies offer more innovative solutions are also right. However, the above considerations point out that Drakestar report is not correct. This is due to the fact that although modern technologies should boost demand for niche product and services, Digital disruption in insurance: Cutting through the noise (2017) indicated the leading trends in InsurTech and only one among them refereed to education ('Gamification'). The general conclusion is then that the development of digital skills in households does not go hand in hand with the development of innovations in insurance companies. The author achieved the set objective. It was possible to

establish a link between household finances, and more precisely spending on insurance, with the technological development in insurance companies. The author also achieved the two additional objectives. The main hypothesis returned as negative.

## 6. Conclusion

The objective of this study was to establish a link between personal finances and digital competences and the development of innovativeness in insurance companies. This article makes a good starting point and inspiration for further considerations in the area of digital skills and the approach of insurance companies to implementing innovations. Further academic work and practical analysis in insurance companies should attempt to point to the future direction: whether new innovative solutions should be made available for a smaller group of clients (with higher digital skills) or should less innovative products and services be available for a wider audience? Further considerations are needed from the perspective of the end client, regarding the readiness of insurance markets in particular countries to introduce InsurTech solutions. It is also worth considering not only the level of digital skills but the linkage to financial knowledge and education of households. Insurances in post-pandemic need a revision that would take into consideration the behavioural approach. It is also crucial to study further the topic of household priorities regarding spending categories, and including insurance spending. It is also worth taking a look at issues related to innovation maturity, the level of sales of particular products, and then comparing that data to the level of financial knowledge and the level of digital skills. This study recommends insurance companies to implement actions to avoid digital exclusion as part of their attempts to raise the level of innovativeness. Various developmental and inclusive programmers should be carried out not only by governmental institutions and non-governmental organizations but also by service providers (here: insurance providers). It is further recommended to carefully analyse the needs of clients, especially their digital needs and limitations, and adjust insurance processes in line with those analysis.

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## WHAT CHANGES IN ORGANIZATION AND MANAGEMENT CAN EMPOWER THE DIGITAL TRANSFORMATION?

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**Purpose:** The main purpose of this research was to investigate what key outcomes of the new digital technologies are observed in selected manufacturing enterprises in Poland and what changes in organization and management area should be realized to support the digital transformation strategy.

**Design/methodology/approach:** To illuminate this uncharted field, the individual in-depth interviews with the selected management experts with extensive experience and practice in industry were tested and their interesting observations and recommendations for top managers and scientists were identified.

**Findings:** The findings from the study indicated that one of the primary effect of the digital transformation is a possibility to process and analyze a huge amount of data in real-time. This gives many significant benefits revealed in this study. One of them is shortening time and an increase quality of decision-making process. These results can provide meaningful insights for subsequent research towards designing new methods and tools for business management using advanced digital technologies.

**Research limitations/implications:** The first limitation is that this research focuses on Polish manufacturing enterprises, but it does not include a division into different type of industry sectors. Therefore, it was not possible to identify changes specific for each kind of sector. A second limitation is associated with the qualitative research which was conducted to identify new changes and cannot lead to the elimination of changes with marginal importance and indicate the most important ones. The quantitative research could bring interesting results and indicate which changes are significant.

**Practical implications:** These research results established a solid basis towards the development of new solutions, business models and methods by answering the question about what should be changed in manufacturing enterprises in digital transformation environment for their own betterment.

**Originality/value:** The article addresses the need for conducting research to develop a new approach, new perspectives and trends in business organization and management so far lacking in the scientific literature. The presented results of in-depth interviews with experts contributes to descriptive and explanatory knowledge on the influence of digital transformation on organization and management areas in manufacturing enterprises.

**Keywords:** organization and management, digital transformation, digital transformation strategy, in-depth interview.

**Category of the paper:** Research paper.

## 1. Introduction

The digital transformation process is not only implementing new technologies, tools and systems, but also a good strategy statement. Enterprises have to be able to respond to changes in all business processes to stay competitive (Albukhitan, 2020). Prior research indicated that company success does not depend only on the technologies, but more important is a strategy realized by the managers that helps to use these technologies to create value and deliver benefits (Ismail et al., 2017; Tonder et al., 2021). A digital transformation strategy (DTS) can help companies, but a main task is an identification of the key changes in organization and management in manufacturing enterprises which allow benefits from the digital transformation (DT) to be achieved.

With technological advances in manufacturing and communication in the past several years related to the Industry 4.0 implementation, multiple enterprises are beginning to experience many benefits as well as limitations. They can offer products personalized to the individual customers' needs and enable a high level of production efficiency and quality (Huang et al., 2022; Yang et al., 2020). Besides, they increase productivity, working conditions, and create new business models (Aquilani, 2020). However, the literature review shows that although the Industry 4.0 concept has concentrated on the efficiency and flexibility of industry, rather insufficient attention has been paid to industrial sustainability and worker's welfare (Xu et al., 2021). Therefore, currently the Industry 5.0 concept has gained popularity (Huang et al., 2022).

The European Commission (EC) also highlights that European industry is a key driver in current transitions and has to aim beyond efficiency and productivity, and strengthen the role of good industry impact on society. It gives an important goal of using new technologies in production processes and overall business, and points out the workers' and society's well-being as a key element of economic development. This approach is manifested in three priorities: "An economy that works for people", "Europe fit for the digital age", and "European Green Deal" (European Commission, 2020). Furthermore, the strong need to develop industry towards three pillars: human-centricity, sustainability and resilience is observed in EC activities as well as in the previous research about current trends in industry (Ivanov, 2022; Madsen et al., 2021).

A closer look to the literature on this topic reveals a number of gaps and shortcoming related to organization and management aspects in manufacturing enterprises. One of the major topics to be analyzed in this field is to identify the key expected outcomes and activities need to be carried out to manage the digital transformation. Prior research can only be considered a first step towards a more profound understanding of perspectives, trends and changes in strategic and operational management. DT is perceived very often as a disruptive process which leads to deeply change the way companies create value, compete, and interact (Said, Mouaad, 2019; Jedynak et al., 2021).

The main aim of this research was to establish what key outcomes of the new digital technologies are observed in manufacturing enterprises, and identify what changes are required in organization and management to deliver benefits from DT. The paper reveals the research results obtained on the basis of interviews with selected experts from Polish manufacturing companies. These findings can be useful for scientists, managers and practitioners to design new and improve present management methods in the digital age.

This paper consists of five sections and is structured in the following way. In the first section, the reasons to conduct research and aim are described. The second section includes studies in the literature which provides a brief overview of the digital transformation and the digital transformation strategy. In the third section a research methodology is explained and main information about interviews is shown. The main research results and a discussion about similar research previously published are presented in the fourth section. Finally, in the fifth section significant conclusions of the article and limitations of study are formulated and future research subjects are recommended.

## **2. Literature Review**

### **2.1. Digital transformation in the context of Industry 4.0 and Industry 5.0 development**

DT entails an integration of various digital technologies and new business models that have changed the way the company operates and delivers value to customers (Ismail et al., 2017; Kiełtyka, Charciarek, 2019). DT is a management strategy that creates new markets and customers changing a traditional industry process and an organization using technologies such as cloud computing, big data, Internet of things, artificial intelligence and create a new business model as a result (Nguyen et al., 2021). DT is a radical change which disrupts organizational culture through new IT infrastructure and new digital skillsets overloading employees as well as an entire organization (AINuaimi et al., 2022). DT can be described as a set of processes which use information technologies to increase flexibility, productivity, and agility of the organizational structure and business processes (Warner, Wager, 2019). The driver of DT in enterprises is usually a wish to support business processes (Schwaferts, Shama, 2018). Digital advancement is caused by a development of such technologies as: big data analytics, cloud computing, mobile technology, Internet of things, cognitive technology, robotic systems, blockchain technology, artificial intelligence (AI), 5G, radio frequency identifier, machine learning, etc. (Pamula, Zalewska-Turzyńska, 2022; Pilipczuk, 2021; Kessler, Arlinghaus, 2022). The prior research has shown that the change of organizational identity caused by digitization leads to the creation organization's digital identity and this is not a result of the digitization process, but it poses a new conceptual category (Jedynak et al., 2022).

DT has developed based on the Industry 4.0 and 5.0 concepts. The Industry 4.0 strategy is concentrated on technological aspects, while the Industry 5.0 puts people and the benefits for society at the center. The Industry 5.0 means human-centric, resilient, and sustainable system design (Ivanov, 2022). This concept includes four main areas: organization, management, technology, and performance assessment at society level, network level, and plant level. It creates a new triple bottom line (Huang et al., 2022; Maddikunta et al., 2022):

- human well-being,
- sustainable society,
- resilient value creation in three dimensions: profit, people, and society.

The Industry 5.0 approach helps to automate and integrate decision making using smartification and digitalization of companies (Kumar, Mallipeddi, 2022). This concept promotes talents, diversity; agility and resiliency of the systems through using flexible and adaptable technologies; and respects planetary boundaries. Generally, all activities should lead to a human centric super smart society with high-quality, comfort lives (Huang et al., 2022).

The previous studies highlighted that DT gives new opportunities not only for production but also for management processes, other operational processes and supporting processes (Gaspar, Juliao, 2020). The research revealed that the entire management in strategic and operational level is transformed as well as the organizational structure, and relations between producers and customers, suppliers and employees. Some researchers pointed out that DT leads to develop “different” company (Felsberger, Reiner, 2020; Gastaldi et al., 2022; Olsen, Tomlin, 2020). The key drivers for a successful DT are open innovations, which improve collaborations and partnerships with customers, suppliers and start-ups. An information exchange between different players is also important and can help to build new business models, new digital value and a seamless customer experience. In addition, culture and change management plays a big role in DT (Raza et al., 2023).

There are six main benefits in manufacturing enterprises from digital transformation: 1) improvement in productivity – development and design processes are faster and delivered information in real-time is better (augmented reality, 3D printing); 2) better quality – automatically indicated quality defects and wastes before they occur (machine learning); 3) cost reduction and better management of inventory (analyzing costs across all stages); 4) product customization; 5) safety at workplaces (robots, sensors) (Albukhitan, 2020; Matt et al., 2015, Jang et al., 2019); 6) lower energy and resource consumption (Kagermann, 2015; Marre et al., 2015). To achieve these benefits, firms need use in practice a digital thinking. It means that they have to collect a huge amount of data and skillfully, deeply analyze data in real-time to achieve greater flexibility, efficiency and value added (Kumar et al., 2020; Thoben et al., 2017).

## 2.2. Digital Transformation Strategy

To survive on the market and effectively apply new technologies enterprises should develop their processes and the way of management to quickly predict and respond to changes as well as stimulate innovation (Albukhitan, 2020). Apart from digital technologies, employees' digital skills, and DTS help to drive DT and financial performance (Teng et al., 2022). DTS requires a formal and structured plan that helps a company to DT. It is critical for the success of digital implementation (Albukhitan, 2020; Ismail, 2017). DTS is defined also as corporate activities which can preemptively react to rapidly changing management environment and create continuous growth using cloud computing, big data, Internet of things, mobile, and artificial intelligence digital technologies (Verhoef et al., 2021).

DTS can improve top executives' decision-making processes (AINuaimi et al., 2022). Currently, a new business model based on artificial intelligence technology is one of the key strategic activity of global companies leads to a successful digital transformation strategy (Verhoef et al., 2021). Digital transformation starts very often from sharing big data that is accumulated through blockchain, Internet of things and cloud computing technologies. Furthermore, operating simulation and systems functioning are supported by artificial intelligence (Huang et al., 2018).

As noted Park and Yang implementation of artificial intelligence (AI) is a key management change to transform enterprise to digital era. They stated that digital transformation can be a success when artificial intelligence is adopted by new personnel and simultaneously with changes in recruitment and job structure (Park, et al., 2020). Moreover, Matt, Hess and Benlian argued that AI development and digital platform consolidation can be achieved using leading business innovation and based on data creation, collection and control management (Matt et al., 2015).

The previous research revealed that digital technology has positive influence on DTS and organizational innovations. In other words, DTS and organizational innovation play an intermediary role between DT and company performance (Tsou, Chen, 2021). In addition, top management plays the positive moderating effect on the relationship between DTS and both IT infrastructure and DT. Besides, research stated that DT has a great impact on the elements of business model (Zhang et al., 2023). In contrast, budget restrictions are a significant limit of DT, especially due to a cost-intensity.

The scientists rightly highlight that enterprises often concentrated on technical development and actualization, rather lack attention has been paid to strategic management, organizational effectiveness and implementation efficiency of new digital technologies (Kitsios, Kamariotou, 2021). Implementation of new technology and business model requires a pressure on management and apply innovations to existing processes and organizational culture. As a result of DTS company should be introduced a new data-centered business model which creates real-time enterprise (RTE) with continuously changing management environment (Kyungtae, Boyoung, 2022).

### **3. Materials and Methods**

#### **3.1. Research Questions and Aim**

The main aim of this research was to investigate what key outcomes of the new digital technologies are observed in selected manufacturing enterprises from Poland and what changes in organization and management should be realized to support the digital transformation strategy and deliver benefits from DT.

For this study, it was of interest to investigate what new changes in organization and management are required in the DT environment. Therefore, all the above issues have led to formulate of the following questions:

Research Question 1 (RQ1): What key outcomes of the new digital technologies are observed in manufacturing enterprises which have an influence on organization and management areas?

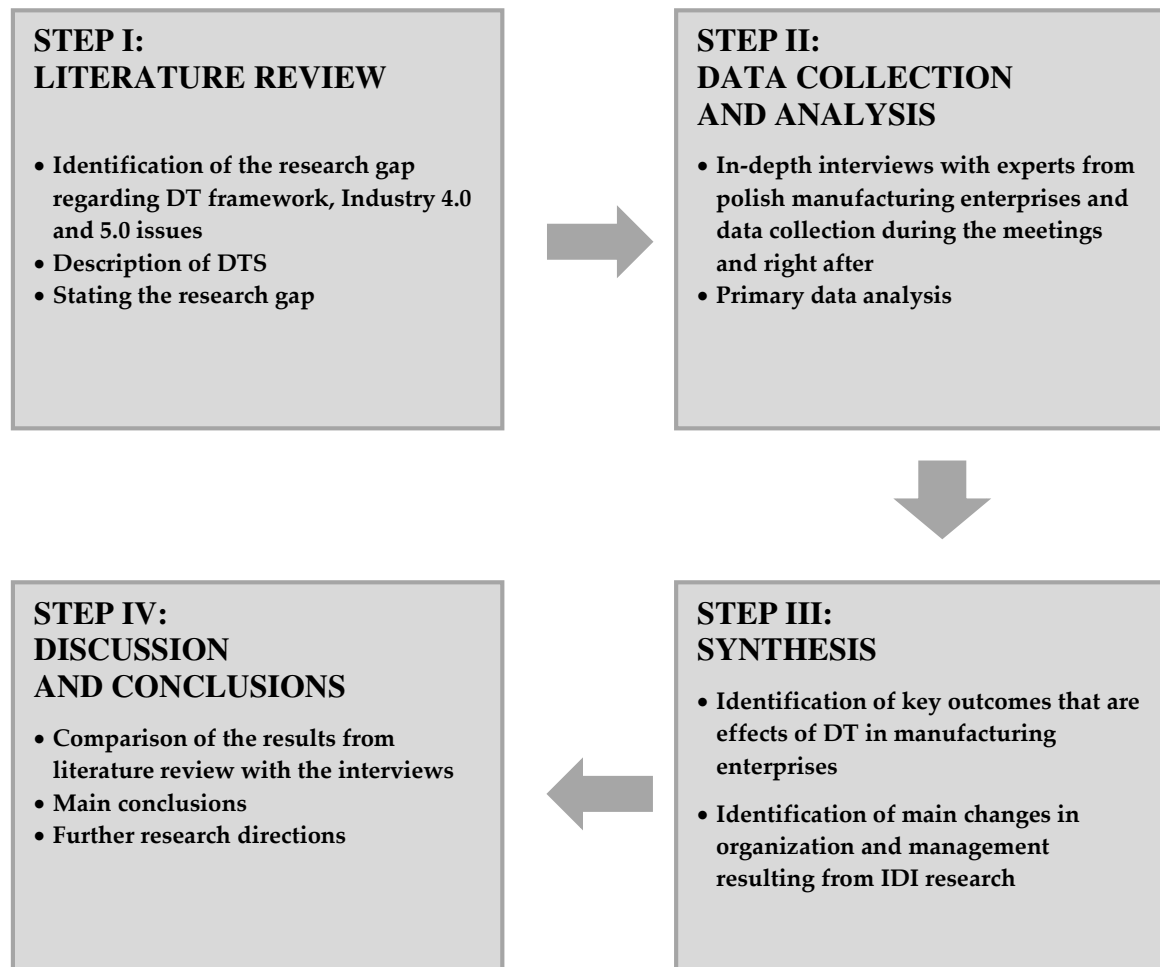
Research Question 2 (RQ2): What changes in organization and management areas are required to create value and deliver benefits from DT?

#### **3.2. Research Methodology**

Given the research aim of this study, the qualitative approach was used. The quantitative research was difficult to conduct due to the inability to verify the competences and experience of the respondents. In addition, qualitative research enabled the selection of respondents from various industries, which leads to more valuable results. This paper reports on the results obtained of the in-depth interviews with experts from polish manufacturing enterprises.

In this research, a four-step methodology was developed and applied. The overview of the applied methodology is presented in Figure 1. In the Step 1. an academic literature was analyzed and an attempt was made to structure the problem area and identify the research gap. The systematic literature review allowed the conceptual framework of DT related to the development of Industry 4.0 and Industry 5.0 as well as the idea of DTS to be synthesized.

In the Step 2. a data collection and analysis were made. For the aim of this study the in-depth interview was used to gather data from interview participants. The in-depth interview (IDI) is a qualitative research technique that is used to conduct intensive individual interviews with a small number of respondents to explore their perspectives on a particular situation, idea, or program (Boyce, Neale, 2006; Rutledge, Hogg, 2020). This kind of review requires a time-consuming conversation with each participant and leads to a discovery-oriented approach. Interview questions are primarily open-ended. IDI enables to get detailed information that sheds light on an individual's experiences, and the derived meaning about a particular topic or issue (Rutledge, Hogg, 2020).



**Figure 1.** The overview of the applied methodology.

Source: own study.

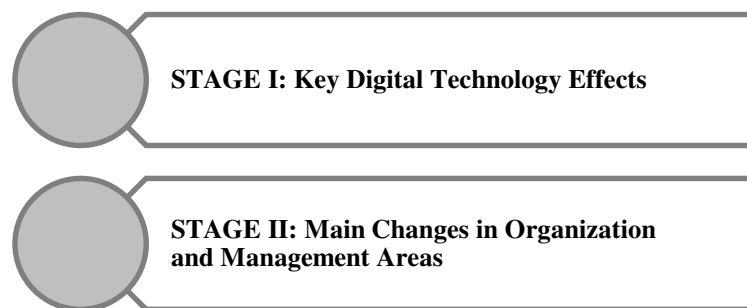
These interviews are useful to explore new issues in depth. Their main advantage is that they provide much more detailed, and valuable information than other data collection methods (e.g. surveys). Besides, they allow a more relaxed atmosphere to collect information to be provided (Boyce, Neale, 2006). With this method, it is possible to easily react based on participants' responses to previous questions. Sometimes a question can be changed or more questions can be asked to get detailed answers or when the participant misunderstands the question (Rubin, Rubin, 2011). The primary limitation of IDI is a time-intensive evaluation activity. Sometimes also there are observed situations that respondents are prone to bias (Boyce, Neale, 2006).

All the aforementioned issues have led to provide the IDI research which has tried to reveal new changes in organization and management related in the DT environment. It should be highlighted that it was a qualitative research. With this aim in mind, in this study, less attention was paid to determining which of the changes is the most important.

The group of medium manufacturing enterprises from Poland which use solutions based on at least one of the following new technologies: Big Data, Cloud Computing, Internet of Things, blockchain technology or augmented reality were selected for this research. Then, specially

selected interdisciplinary experts combining knowledge and at least three-years' experience in fields of organization, management, and new technologies in industrial enterprises in Poland were chosen. These interviews were provided from September 2021 to October 2022 with 46 experts who agreed to be interviewed from the group of specially selected 114 people. The average interview time was 34 minutes.

The provided IDI – within Step 2 - consist of two stages. Firstly, key effects of digital technology were perceived. Secondly, main changes in organization and management of manufacturing enterprise in the DT environment were identified (Figure 2). The interview questions were organized in “funnel” format (Rubin, Rubin, 2011). Firstly, broad questions were asked, and then more specific. The general rule on sample size for IDI is that when the same issues, topics and observations are emerging from the interviewees, then a sufficient sample size has been reached (Boyce, Neale, 2006).



**Figure 2.** Main stages of the in-depth interviews.

Source: own study.

In the Step 3., the synthesis of data collection was performed. Thereafter, the findings of qualitative research and their implications were described based on discussions with experts. Finally, concluding remarks and future research directions were presented in the Step 4.

## 4. Results and Discussion

This IDI research has tried to identify new changes in the area of organization and management characteristic for the manufacturing enterprises and their reasons. The comparison of different directions of change in organization and management indicated by IDI, and common directions of change proposed by both IDI, and previous research is presented in Table 1.



**Table 1.**

*Comparison of the expected changes in organization and management resulted DT based on IDI research and previous studies*

Area of changes	Common directions of change proposed by IDI and previous research	Different directions of change proposed by IDI research
Organizational structure	<ul style="list-style-type: none"> <li>flexible structure</li> <li>flatter structure</li> <li>with decentralized decision-making</li> <li>with flat hierarchy data</li> </ul>	<ul style="list-style-type: none"> <li>horizontal structure</li> <li>simple procedures</li> <li>less bureaucracy</li> <li>more responsibility of employees</li> <li>smaller role of hierarchy in the enterprise</li> <li>lack of competition between departments</li> <li>lower degree of formalization</li> <li>partnership in the implementation of tasks</li> <li>with quick decision making</li> <li>with easy implementation of innovations</li> <li>with process as a central point data</li> </ul>
Organizational learning	<ul style="list-style-type: none"> <li>digital knowledge necessity</li> <li>interdisciplinary team work</li> <li>new skills</li> <li>new competencies of employees</li> <li>easier application of changes</li> <li>faster opportunity recognition</li> <li>openness for innovations</li> <li>interdisciplinary employees' knowledge</li> </ul>	<ul style="list-style-type: none"> <li>a need of increasing motivation of employees</li> <li>openness for change management</li> <li>interdisciplinarity of teams</li> <li>a need of team work</li> <li>increased responsibility of teams for results</li> <li>a quick information flow in both direction</li> <li>a completely new division of remote and on-site work</li> <li>an increase of the employees' independence</li> </ul>
Strategy	<ul style="list-style-type: none"> <li>orientations for organizational agility</li> <li>orientation on processes</li> </ul>	<ul style="list-style-type: none"> <li>quickly implemented strategy</li> <li>orientations for changes</li> <li>orientation for innovations</li> <li>orientations for new technologies</li> <li>outsourcing</li> </ul>
Cost	<ul style="list-style-type: none"> <li>new cost model</li> <li>new system of cost measurement</li> <li>detailed monitoring and control of costs</li> </ul>	<ul style="list-style-type: none"> <li>continuous monitoring and control return of investments</li> <li>increase of indirect costs</li> <li>costs measurement/cost calculation based on data actualized in real-time</li> </ul>

Source: own study.

In the interviews, firstly the respondents were asked what DT implementation effects they noticed. Next, they recognized changes within organization and management areas which help to support enterprise functioning within the DT environment. The interviewees clearly perceived them within organizational structure, organizational learning, strategy, and cost measurement.

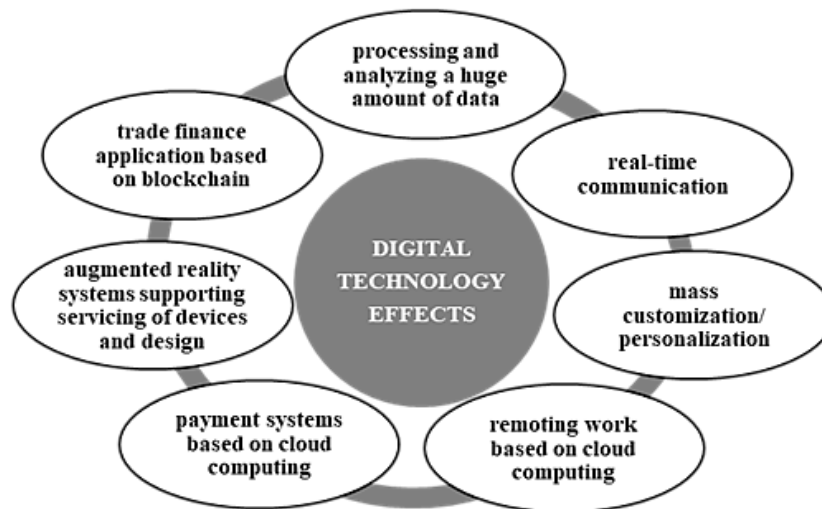
The experts proposed some types of changes. The continuous changes are especially expected in strategy and organizational learning in the DT environment. In contrast, discontinuous changes are relevant in the organizational structure and cost measurement. Furthermore, there are generally all three kinds of changes identified in IDI according to the change strategy criterion: changes aimed at the structure; changes aimed at technology; and changes focused on people.

#### **4.1. Key Effects of the Digital Transformation**

The previous studies generally have expressed that the effect of digital technologies is a need of internal changes in organizations (Tonder et al., 2021) and a direct influence on organizational behavior is clearly observed (Foerster-Metz et al., 2020; Jedynak et al., 2021). The bibliometric analysis of the literature available in Web of Science database reported that the main pillars of business management conclude: value chains, SMEs, B2B, B2C, cyber-physical networks, sustainable development and globalization (Grabowska, Saniuk, 2022). These research results have shown that the most often a large number of existing studies in the broader literature is strongly related the principles of management, relations with the environment, the interaction, cooperation among people, companies, and governments worldwide. The literature review pointed out that common directions of change focused on the decision making flexibility, outsourcing and talent management (Grabowska, Saniuk, 2022).

Undoubtedly, the results of IDI, in comparison with the previously conducted research described in the literature, clearly identified several new, more detailed directions of change as an effect of digital technologies in manufacturing enterprises. Most experts highlighted a processing and analysis of a huge amount of data as an important effect of DT. They also often indicated a real-time communication (RTC). The research participants often claimed that Big Data Analytics, Internet of Things and edge processing enable to analyze business processes in real-time what leads to make decisions “in a second” or “in seconds” and can increase a competitive advantage significantly increasing the quality of decision-making processes in the enterprise. The key digital technology effects for manufacturing enterprises are presented in Figure 3.

Furthermore, some respondents specified mass customization or personalization as a result of digital technologies. They clearly indicated that this trend leads to different production planning (especially customization). It is possible to introduce client’s special requirements. The big data and Internet of things technologies enable very quickly design a huge amount of different variants of products and simultaneously help to organize and prepare production processes for these variants. Some of experts indicated cloud computing as a technology which supports personalization and sometimes customization of different product variants. Hence, some production processes can be easily realized outside enterprise. It was noticed that some experts treated the terms personalization and customization as meaning the same thing during the interviews. Therefore, not every participant of the study precisely formulated and assigned changes to these two types of production strategies, which can be considered a disadvantage of this study.



**Figure 3.** Key effects of DT for manufacturing enterprises based on IDI.

Source: own study.

The interview participants reported also remoting work as well as the payment systems based on cloud computing technology as the outcomes of DT. Many interviewees indicated the trade finance applications based on blockchain technology as important effect as well as an augmented reality system supporting the design and servicing of devices.

#### 4.2. Changes in the Organizational Structure

The previous studies clearly stated that usually enterprises have too inflexible structure to implement digital technologies and it can generate many problems (Albukhitan, 2020). Also they established that a decentralized decision-making is necessary. Especially, the big data technology creates a completely new foundation for management decision-making and enables to improve significantly data mining, optimization and simulation, statistical methods, deep learning and risk analysis (Yang, Wang, 2020). As the prior research indicated the high-performance and flexible smart manufacturing systems require rapid decisions from humans. Accordingly, production planners have to confront with a high level of complexity (Maddikunta et al., 2022). Both the participants of presented interviews and the scientists in previous studies agreed that the organizational structure must be changed in the conditions of DT (Tonder et al., 2021; Gasparetto et al., 2018), and should be flatter and more flexible (Ozkan-Ozen, Kazancoglu, 2021). However, the IDI results show more detailed changes, not just general guidelines.

The participants of IDI call for less bureaucracy, which means shortening the time of making and accepting decisions. Such a solution requires increasing the responsibility of employees for tasks, but also other rules for the employee's control. The interviewees suggest the completely different solution of the employee's control, which seems to be the opposite of those usually used. Namely, they believe that the final results of the implemented tasks should

be controlled, and only in the case of results that do not meet expectations, a thorough detailed control of the stages of task implementation should be made.

The IDI participants highlighted that the quick making decisions can be obtained to apply simple procedures, less bureaucracy, and more responsibility of employees for their tasks. They proposed a horizontal structure. Moreover, they reported that a process should be “a central point” of enterprise. Accordingly, managers have to strive for flexibility of processes and easy implementation of innovations. The experts underline a need of lower degree of formalization in organizational structure as well as an increase of remote work in the DT environment.

### **4.3. Changes in the Organizational Learning**

The previous studies reported that new knowledge, skills and competencies are necessary in the DT environment (Saniuk et al., 2021). Moreover, enhancing employees knowledge has to be integrated with implementation of digital technologies (Albukhitan, 2020; Tonder et al., 2021). First of all a digital knowledge is necessary to provide DT, but also engendering trust and developing teams are very significant (Warner, Wager, 2019). In the DT environment, enterprises should be innovative in terms of new product, process and service development; should continuously create new competencies, knowledge and skills; and strategic alliance being able to enhance capabilities, build innovation and respond quickly to market changes. Besides, the studies show that the organizational culture should be transformed towards more openness, and an easier application of changes within the technological sphere. Moreover, an organizational agility is also important (Tonder et al., 2021). The scientists identified a need of interdisciplinary knowledge of employees and an increased role of interdisciplinary team work which goes towards very quickly adaptation to frequent changes and opportunity recognition (Letmathe, Rossler, 2022). A necessity of multi-disciplinary approach, new skills and capability were also underlined in prior research (Culot et al., 2020).

The big data technology and networked sensors make faster and easier to analyze and collect a huge amount of data and open the possibility for customization in manufacturing processes (Nahavandi, 2019). Many studies highlighted that the flexibility is expected in a DT era which can be achieved through a better coordination all company activities focused on processes. Besides, a traditional paper-based processes are no longer accepted, because are too time-consuming and generate too high cost. Employees spend a huge number of man-hours taking their time performed many redundant, repetitive tasks (Albukhitan, 2020).

The interview participants reported that a role of the organizational learning is significant in the DT environment. Besides, they pointed out that motivation of employees, openness for change management and new interdisciplinary employees' knowledge are also necessary. Interestingly, the interviewees identified a strong need for team work. They also noticed that teams should be responsible for results and interdisciplinary. Simultaneously, the employees' independence should increase. This leads to a faster decision making and a better decision

quality. IDI showed also that a quick information flow in both direction is necessary to shorten the information flow and make decisions faster. The much better quality of making decisions based on analysing a huge amount of data was highlighted very often.

#### **4.4. Changes in Strategy**

The previous research noticed that a digital strategy without doubt enables an effective and efficient DT process (Tonder et al., 2021). The research suggests to develop procedures to promote organizational agility, because more agility of enterprises leads to the successful DT. Therefore, enterprises have to change their structure, processes and management towards more intensive agility (Tonder et al., 2021; Warner, Wager, 2019).

The respondents of the presented interviews highlighted that strategy should be strongly oriented on “quick changes”, “innovations” (most often “organizational innovations”) and “new advanced technologies”. They indicated most often Big Data Analytics, Cloud Computing, Internet of Things and mobile networking. Besides, they have observed a need of focusing on outsourcing, which helps to increase flexibility and agility of manufacturing enterprises. The IDI research also has shown that a strategy has to be implemented very quickly and constant monitoring and control of its realization is necessary.

#### **4.5. Changes in Cost Measurement**

Many scientists pointed out that a new cost model is necessary in the DT environment. Moreover, a new system of cost measurement and detailed monitoring and control of costs based on information collected and processed in real time nowadays is necessary (Zhichao et al., 2021).

The IDI respondents indicated “strong pressure to control and monitor costs and the return of investment in DT”. They have observed that a saving cost is now a main cause to implement the digital technologies in manufacturing enterprises. The experts reported a need of using “a new costing method” and/or “new cost model”. This need is especially highlighted when an enterprise offers customized products. Many interview participants expect a new costing method which can measure costs included data actualized in real-time. They pointed out that it is a real problem currently to achieve a unit product cost in real-time for different variants of products or to measure a real unit cost of customized products by using nowadays applied costing methods.

## 5. Conclusions

This study set out to find answers to questions: 1) What key outcomes of the new digital technologies are observed in manufacturing enterprises which have an influence on organization and management areas?; and 2) What changes in organization and management areas are required to create value and deliver benefits from DT?

The findings of IDI clearly indicate that DT is a huge challenge for manufacturing enterprises and can lead to many benefits if there is complex and correctly prepared for changes in all company areas. The provided interview experts revealed many effects of the digital technologies implementation which have impact on management and organization. They have established that processing and analyzing a huge amount of data in real-time mode is significant, and means multi-criteria analysis of huge amounts of data and receiving analysis results in a few seconds. This is possible thanks to tools based on Big Data technology. Besides, the participants highlighted an important role of a real-time communication (RTC). They indicated also remoting work, payment systems based on cloud computing technology, the trade finance applications based on blockchain technology, as well as an augmented reality system supporting the design and servicing of devices as the important outcomes of DT.

The most obvious finding to emerge from this study is that there is a strong need of changes within organization and management in manufacturing enterprises which can empower DT and deliver benefits. The most important of them include shortening the response and decision time, reducing costs and increasing the competitiveness of the company. This study has shown that the organizational structure should be horizontal with simple procedures, more responsibility of employees, smaller role of a hierarchy in the enterprise and a competition between departments. The findings reported that less bureaucracy, lower degree of formalization and partnership in the implementation of tasks are also expected.

The next major result was that the organizational learning in the DT environment should be oriented on an interdisciplinary knowledge of employees, a team work and an increased responsibility of teams for results. The interviewees noticed an orientation on building a systemic approach among employees, open to changes and new knowledge and skills. Besides, an importance of a quick information flow in both direction and a completely new division of remote and on-site work are observed. The strategy should be oriented on new technologies, innovations and methods and tools which help quickly to realize strategic goals. This study reported that the DT environment requires continuous monitoring and control return of investments and a huge challenge is a change of cost methods and models which can actualize data in real-time. These study results contribute to descriptive and explanatory knowledge on the influence of DT on organization and management areas in manufacturing enterprises.

The provided IDI research is not without limitations. This study focuses on Polish manufacturing enterprises, but it does not include a division into different type of industry sectors. Therefore, it was not possible to identify changes specific for each kind of sector. Although they could be included in future research, but this represents a big challenge. In addition, a second limitation is associated with the qualitative research which was conducted to identify new changes and cannot lead to the elimination of changes with marginal importance and indicate the most important ones.

The main direction of future studies is to build new management methods, tools and business models which support development of manufacturing enterprises in the digital era. They should base on information revealed in above described in-depth interviews. Besides, the quantitative research could bring interesting results and indicate which changes are the most significant.

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## SOCIAL CAPITAL AS A FOUNDATION FOR POLISH SELF-ORGANISATION FOR WAR REFUGEES FROM UKRAINE

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**Purpose:** The aim of this article is to verify the thesis on the importance of social capital in the self-organisation of Polish society. The subject of the study was aid activities for refugees from Ukraine. Social capital is understood as a set of basic ties and relations occurring between members of a given social group. It is cemented by such values as trust, honesty, fulfilment of contracts and obligations, and action for the common good.

**Design/methodology/approach:** The verification of the adopted thesis required the application of methodological pluralism using an analysis and synthesis of the literature on social capital. In-depth analyses were also made of the results of survey research on the aid activities of Poles provided to refugees in the period February-April 2022.

**Findings:** The results of the survey indicate that the massive influx of Ukrainian citizens has unleashed resources of bonding and bridging social capital in Polish society. In the first weeks of Russia's armed aggression against Ukraine, it was primarily individuals (informal capital) and then NGOs (formal capital) that rushed to help the refugees. During this time, the institutions of the state launched legal, organisational and financial procedures. The spontaneous, grassroots self-organisation of Polish society showed once again that Poles have a stock of social capital that is activated especially in emergency situations.

**Originality/value:** The findings are invariably relevant for further scientific work on the development of society's self-organisation skills. In emergency situations, when state structures are not yet ready for anti-crisis measures, it is society that assumes the burden of responding to threats. The accumulation of social capital makes these actions effective and serves the common good.

**Keywords:** social capital, self-organisation of society, war in Ukraine, refugees.

**Category of the paper:** research paper.

## 1. Introduction

The historical experience of the Polish nation shows that society has a special ability to self-organise in situations that threaten people's lives and health (Goryń, 2019). This is the ability of Poles, observed for generations, to self-organise socially in situations of misfortune or danger, which has been repeatedly trained in various political, military and social conditions.

Such historical experiences include the period of partitions (1772-1918), during which this society had to survive and fight to preserve its national identity in the absence of its own state for 123 years (Maślanka, 2020). The period of World War II (1939-45) was the time when Poles organised the Polish Underground State. It was a phenomenon of military organisation on a global scale (Davis, 2003).

Polish society's capacity for self-organisation and self-help (Brzezińska, 2011), often referred to as civic training (Strzembosz, Zakroczyński, 2021), resulted in the emergence of very numerous, spontaneously formed underground organisations in the first years of World War II, ready to fight the German and Soviet invaders.

Thanks to skilful behaviour, the tragic balance of almost 12 million war casualties was significantly reduced as a result of earlier preparation of the population for the war effort (digging anti-aircraft ditches, participation in firefighting, population dispersal operations and organisation of local defence) (Szmitkowski, 2012) and a resistance movement and underground state developed on a scale unprecedented in Europe.

Finally, the 'Solidarity' uprising initiated in the 1980s, which led to political, social, economic and military changes not only in Poland, but also in Europe and the world (Davis, 2004; Domber, 2008; Sussman, 2010). It is also worth mentioning the events related to the death of Pope John Paul II, which in April 2005 triggered a wave of unity and grief among the Polish nation after the loss of the great Pole.

In the modern history of Poland, a significant experience in terms of the preparedness of the state and the self-organisation of the population to act in an extremely difficult situation was the flood that hit the south-western provinces in July 1997. Shortcomings, indeed a lack of efficient organisation and coordination of activities, highlighted the backlog that had developed in Poland after a period of preparation to counter military threats only (National Security Office, 1997, pp. 18-20). The central and local government administration, the specialised services, inspections and guards, which in total numbered 75,000 and took part in the fight against the element, as well as thousands of flood victims, were put to a special test. The flood demonstrated that when organisational structures at the various levels of government fail, relying on external help from rescue services is unreliable, the most effective way is skilful and rapid self-organisation around saving the common good (Kitler, Skrabacz, 2010).

To historical conditions, one should also add geopolitical conditions, which result from the geographical location in the immediate neighbourhood of Russia and the age-old perception of Russia as an enemy not only of the Polish state and nation, but of the whole of Europe, as evidenced by historical and contemporary experiences (Yurgens, 2014; Czuperski, Herbst et al., 2015).

Thus, the experience gained in the course of warfare and during natural and technical disasters allows us to conclude that in any situation the civilian population suffers the greatest losses. Only skilful self-organisation for the common good of security and the readiness to take defensive action, which consists of triggering natural, instinctive human (social) actions in one's environment in the sphere of security (Defence Knowledge Society, 1997), make it possible to minimise the consequences of an incident and to limit the number of casualties and losses to property and the environment.

Based on the natural and trained readiness of Polish society to self-organise in an emergency situation, the grassroots community initiative to assist war refugees from Ukraine should not come as a surprise.

Since 24 February 2022, the beginning of Russia's aggression against Ukraine, more than 13.5 million refugees from Ukraine, mostly women and children, have crossed the Polish-Ukrainian border. A total of 11.733 million people have returned to Ukraine since the start of the war (Border Guard, 2023). As of June 2023, there were 872,000 people of Ukrainian nationality in Poland, of whom 39 per cent were women and 11 per cent were men of working age (Ukrainian in Poland, 2023).

This huge, sudden and unexpected influx of people of foreign origin, who, in the face of the armed aggression of another country, left their homes in panic and haste, taking only the most important and necessary things, released in Polish society unbelievable resources of social capital and unconditional social energy, which was channelled into various types of assistance for people in need. Suffice it to say that 70 per cent of Polish society became involved in helping the refugees, and the assistance took a variety of forms, ranging from financial and material support, to voluntary activities at bus and train stations and at reception and information points organised at the border, to making one's own homes and flats available to the war refugees.

Thus, by synthesising historical and contemporary experiences in the area of the Polish society's ability to organise itself into joint, grassroots and spontaneous actions in favour of those in need of support and assistance, the aim of this article is to demonstrate the importance of social capital in the self-organisation of society in an emergency situation. The subject of the research was social capital, the existence of which had a significant impact on the actions taken by Poles in support of war refugees from Ukraine in the first months of the war (February-April, 2022). The research problem was framed as follows: to what extent did the social capital, the accumulation of which took place in Polish society in the face of warfare in Poland's immediate neighbourhood, influence the self-aggrandisement of the aid provided by Poles to the Ukrainian population? On this basis, the authors put forward the thesis that social capital, understood as

a network of mutual relations based on trust and striving to create the common good, is a necessary and indispensable condition for social self-organisation, especially needed in an emergency situation threatening people's life and health.

## 2. Methods

In the course of analysing the literature on social capital, the authors noted that the interests of researchers are mainly maintained in the sociological research stream, while there is a significant gap on the importance of social capital in an emergency situation, such as the war in Ukraine and the exodus of Ukrainian citizens. As Izabela Rycerska points out, there is a lack of studies on this issue in strictly scientific journals, and researchers are left to explore materials posted mainly on internet portals (Rycerska, 2022).

In one of the few scholarly publications on the subject, Monika Wojakowska states that 'despite being surprised by the scale of war refugees, Polish society has passed the test of empathy, openness and willingness to help' (Wojakowska, 2022). Izabela Rycerska discussed the legal aspects of the assistance provided, pointing out that "immediate action was taken by ordinary citizens who, in a more or less organised way, helped the Ukrainians arriving en masse, providing them with food, clothing, shelter and transport, often to places far from the border, not only in Poland but also in Europe. To those who decided to stay in Poland, Poles made their flats and houses available" (Rycerska, 2022). Valuable information is provided by a report on the role of Polish society vis-à-vis wartime migration, in which a team of authors from the University of Warsaw, concludes that the behaviour of Poles was a reflex (imperative) to help in a situation described as very hurtful to the victims of Russian aggression (Fuszara, 2022). On the other hand, from the perspective of Ukrainian war refugees, the assistance offered by Poles was well assessed, as indicated by the authors of a study containing the results of empirical research among the Ukrainian population arriving in Poland. Volunteers, people working at reception points at the border and Polish uniformed services were rated highest (Długosz, Kryvachuk, Izdebska-Długosz, 2022). The creation of the image of refugees in the Polish press was addressed by Natalia Zawadzka-Palucka (2023), who pointed out the potential of the media in shaping positive attitudes towards refugees, as evidenced by citizens' accounts of Ukrainians.

International scholarly publications are dominated by works on the impact of the war in Ukraine on the international order. Insightful analyses are presented in a collective study on the global consequences of the war. The authors posit that the political, economic, economic and social consequences will be massive, far-reaching and lasting (Garicano et al., 2022).



A multifaceted analysis on Ukrainian refugees by Carmen González Enríquez (2022) is worthy of research attention. The author points out that the UN warned that the number of refugees leaving Ukraine could approach 4 million. After several weeks of war (3 April 2022), the UN refugee agency (UNHCR) reported that the number of refugees had reached 4 215 000. At that time, 2,451,342 people had arrived in Poland. The total number of refugees was the largest exodus in Europe since World War II and one of the largest in the world since then. In addition, the author points out that Ukrainians who left their country, overwhelmingly women and children, were met with open arms in the countries bordering the EU, which receive the majority of newcomers. They have been welcomed by a number of civic initiatives, both in the border states and in the rest of the EU.

In an effort to validate the research assumption made, interdisciplinary research methods were used, including an analysis and synthesis of the literature on social capital theory, its typology and research capacity. This made it possible to systematise the issues related to the research subject. Through the use of induction and deduction, it was possible to interpret the results of the research in a logical manner and to draw conclusions allowing for the formulation of conclusions. The empirical layer makes use of nationwide and European statistical surveys on the level of social capital and its components over recent years in selected EU countries, with particular emphasis on Poland. Using the results of survey research, the attitudes of Poles towards Russia's invasion of Ukraine are presented. The advantage of this method of empirical research was the systematic collection of information in a relatively short period of time, which allowed for in-depth analyses of the provision of aid by Polish society in specific time sequences. Particularly taken into account were the first months of the armed invasion (February-April 2022), when there was a massive influx of Ukrainian refugees into Poland.

### **3. Results**

#### **3.1. Social capital as an imperative for the organisation of society**

When people form a given community, they interact with each other in certain ways, based on certain values and moral norms. These allow people to cooperate fairly and in partnership, as they are accepted and respected by all members of that community. Networks of mutual relations are thus formed, resulting in a certain level of social resources, called social capital.

The concept of capital itself has been extensively developed in the work of many scientific disciplines, and its understanding can most simply be put, based on the theory of the sociological sciences, as an individual resource used in the process of occupying and maintaining a social position. This resource can be inherited, created, exchanged for another or bought (Bartkowski, 2007). As far as the meaning of the word social is concerned, it can have

several meanings, including such meanings as (Polish dictionary, 2005): pertaining to society or a part of it; produced by society and owned jointly by it; intended to serve society; working disinterestedly for the good of some community; pertaining to the attitudes or actions of the majority of the members of society; organised by some community independently, without the participation of the state.

Social capital is identified alongside forms of capital such as human, physical, economic or cultural, and in the last 20 years there has been a marked increase in research diagnosing and forecasting the role of social capital not only among different social groups (Volpe et al., 2023; Bin Yu et al., 2023), but also in many professional settings (Medina, Sole-Sedeno, 2023). This is pointed out by J. Field (2003), who reports an exponential increase in the use of 'social capital' as a keyword in the international press in the following figures: before 1981, the term appeared a total of 20 times; between 1991 and 1995, these appearances were already 109. Between 1996 and 1999, the number reached 1003, and not only does the increase show no sign of abating, but one can even speak of an explosion of interest in the term among academics.

Social capital has therefore, as a subject of theoretical and empirical research, been of interest to sociologists, economists, psychologists and political scientists for many years. This is a result of its universal and interdisciplinary nature, which makes it possible and even necessary to study it in conjunction with other types of capital, both in the macro, meso and micro social dimensions (Sierocińska, 2011). This is because it constitutes a kind of foundation for the development of local and regional and national communities, without which even the richest societies and states with well-established democratic principles cannot function fully and well. In the opinion of L. Paterson (2000), this is because civil society is autonomous and the networks of social capital that embody it are primarily the independent bottom-up activities of citizens rather than the state.

The scholarly output on the subject of social capital has produced a number of studies by renowned international scholars, among whom it is worth mentioning: Pierre Bourdieu (1980; 1986), James Samuel Coleman (1988; 1990), Robert Putnam (Putnam, Leonardi, Nanetti 1995; Putnam 2008), Francis Fukuyama (2000), Alejandro Portes (1998, 2000) and Michael Woolcock (1998). Among Polish researchers, works by Andrzej Matysiak (1999), Janusz Czapiński (2008), Jerzy Bartkowski (2007), Piotr Sztompka (2016) and Katarzyna Sierocińska (2017) are noteworthy. The development of the security sciences, especially in terms of the social aspects of security, has led to an increased interest in social capital also in this social science discipline, with researchers highlighting its importance for the proper functioning of local communities, including the creation of security at local, regional and national levels (Urbanek, 2009; Gierszewski, Pieczywok, 2019; Skrabacz, 2023).

Building on the classical concepts developed by early researchers of the phenomenon, including Pierre Bourdieu, James Samuel Coleman, Robert Putnam, Francis Fukuyama and Alejandro Portes and Michael Woolcock, the following generalised and integrated definition was adopted for further research:

Social capital refers to a set of certain basic values and norms, such as trust, honesty, truthfulness, honouring contracts and keeping one's word, reciprocity in relations with others, and remembering one's duties and obligations.

Its source is social networks governed by moral or customary norms (and not, or not only, formal rules of law) that bind the individual to society in a way that enables him or her to interact with others for the common good.

The mobilisation of social capital resources is particularly important in emergency situations where there is a threat to human life and health, loss of property or environmental degradation.

Social capital is directly related to human capital as it refers to the stock of knowledge, skills, health and vital energy contained in each individual and in society as a whole. Human and social capital influence the level of economic (financial) capital, which determines the wealth of a country and its citizens.

Taking the above definition, three approaches to social capital can be proposed (Bartkowski, 2007):

1. A functional approach, which views social capital through the functions it performs, without, however, treating it as a universal phenomenon, occurring everywhere in an identical or similar form. Social capital consists of many elements of social life that are linked by their social effect, they serve to create individual or collective wealth, and social capital itself is revealed primarily in action.
2. An approach based on the paradigm of collective action, cooperation and networking. This framing focuses on the collective action, network and cooperation perspective, and social capital is defined as the moral-social infrastructure of interaction and coordination of human behaviour. Social capital refers to those features of social organisation that facilitate its development, as it enlarges the range of benefits obtained through cooperation and social exchange and increases the productivity of existing resources.

The structural approach, according to which social capital is closely and organically related to the social structure and is one of the three basic forms of capital in human communities, alongside economic and cultural capital.

The theoretical dimension of social capital thus outlined will provide a starting point for further research into its activation in the face of Russia's armed aggression against Ukraine.

### **3.2. Typology of social capital and its measures**

Analysing the connections occurring in a given community, social capital researchers have distinguished at least several types of social capital, taking into account the quality of the relationships occurring between members of a given community and the entities in relation to which they occur (Woolcock, 1998; Działek, 2011).

The interpretation of R. Putnam, who distinguished between bonding and bridging capital, was taken as the basis for distinguishing different types of social capital. According to this researcher, bonding social capital refers to (highly) homogeneous ties, such as between family members, neighbours and close friends. Bridging social capital refers to heterogeneous ties between individuals and therefore includes ties between people from different social groups. Connective social capital refers to ties between communities that cut across status and similarity. In addition, R. Putnam makes a distinction between cognitive and behavioural social capital resources, i.e. those that result from the views of the individuals concerned and those related to behavioural tendencies (Putnam, 1995; Bartkowski, 2007).

Bonding social capital results from the ties that occur between family members or relatives. It is also referred to as informal-family capital, as opposed to informal-social-neighbourhood capital (CSO, 2020). As the name suggests, it occurs between members of a community who are linked to each other by relations of kinship, neighbourhood or acquaintance.

F. Fukuyama points out, however, that this comes at the expense of trust in people outside this nevertheless narrow circle, resulting in the formation of unhealthy relationships in which individual interests prevail over group interests (Fukuyama, 2000). Hence, R. Putnam, calling this type of social capital inclusive, argues that the creation of strong intracultural loyalty, can also create strong extracultural antagonism (Putnam, 2008).

A different form of social capital is bridging capital. It is also called associational because it occurs between members of third sector entities (CSO, 2020). It consists of cooperation between people who are not related to each other and even often do not know each other at all. Their cooperation stems from a willingness to act for the common good. R. Putnam calls this type of capital exclusive (Putnam, 2008), because social ties are outward-looking, linking individuals from different structures into heterogeneous groups, despite differences in values or different life experiences. Thus, this type of social capital - bridging (exclusive) - is a particularly valuable manifestation of civic activity, in which the creation of the common good prevails over the particular interests of individuals.

In the literature it is also possible to distinguish a third type of social capital, called linking by M. Woolcock, which occurs in non-horizontal but vertical relations between social strata in hierarchical power structures and various institutions (Woolcock, 2001).

The division into the aforementioned types of social capital presented here responds to the need to sort out its many forms, as there are many inconsistencies in this area. Some authors attribute capital of a bridging nature not to NGOs and other associations, but to people outside the family, i.e. acquaintances and friends. This is problematic insofar as different types of relations and network links occur among people who know each other (in the case of friendship and neighbourhood groups) and others among people who share a common goal of action (in the case of third sector entities).

M. Wojciechowska (2017), in turn, indicating the diversity of social capital, lists the following types: personal (individual) capital - collective (group) capital; bonding capital - bridging capital - linking capital; capital based on homophily - capital based on heterophily; capital based on inclusive relations - capital based on exclusive relations; formal capital - informal capital; positive capital - negative capital; structural capital - relational capital - cognitive capital. In adopting this division of social capital, it is worth noting that, although its complex typology results from the criterion used, the different types of social capital are identical to each other, as in the case of formal and informal capital and the corresponding binding and associative capital, as R. Putnam and M. Woolcock wrote about.

According to J. Bartkowski (2007), social capital has two levels: individual and collective. In the case of the former, one can speak of individual social capital, resulting from social or ethnic background, or accumulated capital in the form of an established network of relationships. In addition, social capital also has a collective aspect, as it is "carried" by a specific social group. Its elements are acquired and instilled in the course of socialisation, the adaptation of an individual to life in a group, and access to it is provided by group membership. The same author also proposes to consider social capital in a group-layer dimension, as a feature of specific internal groups, which are an intermediate level between the individual and society (micro and macro social system). The group-layer aspect is the problem of the differentiation of social capital resources within a collective. It can be grounded in the social structure of the group, but can also be a consequence of its ethno-cultural composition. The group-stratum level is clearly marked if social capital is shared by members of specific strata and the main mechanism for its acquisition or lack thereof is membership. All three of these levels arise depending on whether we analyse the effects of social capital from the side of the individuals themselves, or as a dimension of internal group stratification, or because of its operation in the community as a whole. These are not fundamentally different forms of it, but rather different aspects of the social capital phenomenon.

For the purposes of further research, based on an analysis and synthesis of the body of scholarly work on the different types of social capital, the following division was adopted in order to organise and generalise it:

- binding social capital, which refers to relationships within or between relatively homogeneous groups whose members are related to each other or live in close proximity to each other. This type of capital is also called exclusive, informal and unitary, homogeneous in nature. It can have a positive or negative colouring;
- bridging social capital, which refers to the external relationships that exist between people who want to cooperate with each other because of a common goal of action. It refers to people acting in associations of a formal nature and manifests inclusive and heterogeneous tendencies;

- linking social capital, which refers to the relationship between people or social groups and power at different hierarchical levels. Unlike the previous two, it is vertical rather than horizontal in nature. An example of this type of social capital could be the cooperation of residents with the municipal authorities in the implementation of the civic budget.

It is worth adding that in a well-functioning environment it is important that social capital is present in its many types, whether bridging, binding or connecting. A common feature is the building of bonds and relationships based on mutual trust, activity and cooperation for the good of the community, which becomes particularly important in an emergency situation. Hence, a community model in which all types of social capital are present, i.e. binding, bridging and connecting, seems ideal. This makes it possible, on the one hand, to protect the interests of all group members and, on the other hand, to control each other's actions and contain undesirable behaviour. In addition, strong bonds are formed in the relationship between the local authority and the inhabitants of the municipality, who trust each other while controlling each other's actions.

No less important than the differentiation of social capital is its measurement. The multitude of approaches in this matter leads to a broad presentation of measurement methods and yardsticks to be analysed. At the outset, it is worth pointing out that some of them cannot be taken into account in the Polish reality, if only because they will not constitute a reliable indicator. It should also be pointed out that, in the opinion of some researchers, social capital is a theoretical concept which finds no equivalent in empirical reality. As far as theoretical concepts are concerned, this is not unusual: it equates here with the concepts of power or social class, which retain a heuristic meaning even if they cannot be directly operationalised and measured.

Reviewing the methods of measuring social capital, the following concepts can be identified according to selected authors (Skrabacz, 2023):

1. Robert Putnam proposes to measure social capital by means of specific statistics, such as membership in voluntary groups or the number of such groups, voter turnout, the amount of charitable spending and magazine readership (Putnam, 2008).
2. Francis Fukuyama assumes a different way, namely to measure the lack of social capital, based on variables such as crime rates, divorce rates, suicide rates, the amount of drug and other stimulant use (Fukuyama, 2003).
3. Jean-Marc Callois proposes to use the following indicators to measure: the percentage of people who have not reserved their number in the telephone directory; the percentage of people who have written off amounts intended for donations in their tax return; voter turnout; the number of associations; the number of bars and cafés; the number of sports associations (Cannon, 2008).

4. Fabio Sabatini bases his measurements on the level of civic engagement, the components of which are the number of associations, civic awareness and political participation (Sabatini, 2005).

For the purposes of the research conducted on the issue of the influence of Poles' social capital on their readiness for social self-aggrandisement in favour of Ukrainian refugees, measures characteristic of Polish social reality were selected and will be presented later in the article.

## **4. Discussion**

### **4.1. Putting poles' social capital to work for Ukrainian refugees**

The starting point for analysing the stock of social capital necessary for social self-aggrandisement in favour of those in need is its division into bonding and bridging capital. The former refers to activities undertaken by individual people who are not affiliated to any non-profit entity. It was these individuals, with a sense of the humanitarian idea of helping people in need, who were the first to take action to alleviate the suffering caused by the war. A huge social energy was activated, thanks to which the activities related to intercepting refugees at the border, providing them with food, transport and organising temporary accommodation for them were taken over by individual citizens (Grabowska, Pięta-Szawara, 2023).

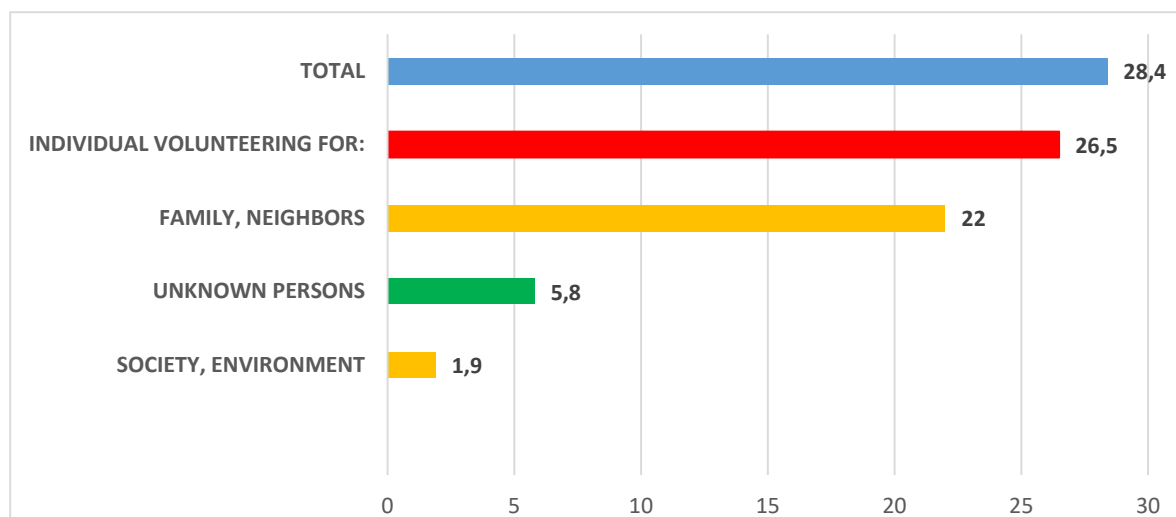
The highest intensity of Poles' activity was visible in the first three months of the war, during which 77% of adults became involved in the aid campaign.

A survey by the Centre for Public Opinion Research conducted in 2022 shows that almost two-thirds of respondents (63%) helped refugees from Ukraine. This was more often done by respondents with higher education (79%), managers and professionals (83%), technicians and associate professionals (80%), administrative and office workers (75%), respondents with the highest income per person in the household (PLN 3,000 or more - 76%) and residents of the largest cities (73%). Those most involved in religious practices also stood out in this regard (77%). The relatively largest number of respondents declaring commitment to refugees from Ukraine lived in the Kujawsko-Pomorskie (81%), Małopolskie (77%) and Podlaskie (72%) provinces (CBOS, 2022).

At this point, it is worth noting the pro-social behaviour of Polish society as expressed in the willingness to work in the form of volunteering. Why? Because volunteering in Poland is treated as an unpaid, conscious and voluntary activity for the benefit of others, going beyond family and friendship ties (Act on Public Benefit Activity and Volunteering, 2003). Numerous voluntary groups are able to dedicate their time and abilities to people in need, offering various

types of support and showing concern for the common good. The attitudes displayed by volunteers are based on a selfless will to serve other people and are not motivated by the desire to find a job and earn money. A volunteer's involvement is voluntary and therefore based on his or her goodwill and not on some binding norm (Bsoul, 2011).

In 2020, 92.6 per cent of registered non-profit organisations declared the use of community service, while showing approximately 2.5 million volunteers, of which 1.9 million were members of the organisation (Goś-Wójcicka, 2022). The average number of volunteers working at least once in 2020 was 29 people, while for half of the NGO-s it was no more than 8 people. The level of social activity, as well as its extent, is mainly related to the education and material situation of the respondents - the better educated they are, the higher the income per person in the family and the better their material conditions, the more often they engage in group social work. On the other hand, a difficult life and material situation and low education are generally not conducive to social activity. What is characteristic of Polish volunteering? Certainly, the fact that people are more willing to engage in disinterested help for the benefit of loved ones, family, relatives, neighbours - 22% of declarations, than for unknown persons - 5.8% of responses (Central Statistical Office, 2022). Thus, the essence of helping lies in who we want to help (Figure 1). It is also worth adding that the idea of helping within the framework of informal binding capital (family, colleague and neighbourhood relations) contradicts the statutory definition of volunteering, which emphasises actions for the benefit of others beyond the above-mentioned ties.



**Figure 1.** Percentage of volunteers in Q1 2022, by type of volunteering (in %).

Source: Central Statistical Office, Volunteering in 2022. Warsaw, 2022.

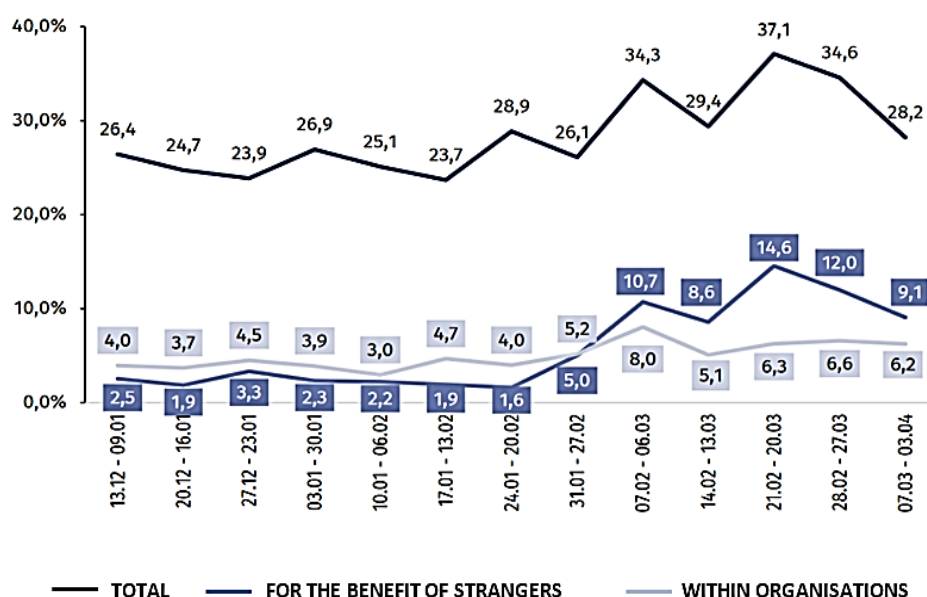
Furthermore, when we analyse volunteering by age group, we find that those aged 35-54 are the most active (Central Statistical Office, 2022). These are therefore adults of working age. On the other hand, looking through the lens of the development of social capital resources, voluntary activity is most expected in the pre-working age (young people) and post-working age (seniors) (Skrabacz, 2023). Why exactly there? Because adolescents entering adulthood gain social savvy during volunteering, become sensitive to the needs of others, learn to make



decisions, make choices, manage their own time, communicate effectively and build interpersonal relationships and solve problems. If they enter adulthood with this positive baggage, they will be more successful in both the private and professional worlds than those who have never gone through the 'school' of volunteering. Meanwhile, the rate of involvement of young people aged 15-24 was in 2022. 26.7% (Central Statistical Office, 2022).

Turning to the so-called 'silver volunteering', i.e. social activity of seniors, it is worth noting that social work in this age group provides an opportunity to maintain psycho-physical well-being, is an opportunity to make new friends, share work experience and achieve the satisfaction of feeling needed. The social activity rate in this age group (55-89) was 25.6% (Central Statistical Office, 2022).

Meanwhile, with the influx of multi-millionaire war refugees to Poland, volunteer activity rates rose sharply between February and April 2022, to the benefit of strangers (Figure 2).



**Figure 2.** Percentage of volunteers in the time frame: 13.12.2021-03.04.2022.

Source: Central Statistical Office, Volunteering in 2022. Warsaw, 2022.

According to the data, between the beginning of February and the beginning of April 2022, the rate of volunteering activity at its peak was 14.6% for the benefit of strangers. To this should be added NGO-s activities (6.3%).

Along with the readiness for tangible aid activities, mass financial and in-kind collections also took off rapidly, testifying to the enormous generosity of Polish society. Based on data contained in a report by the Polish Economic Institute, it can be concluded that during this period Poles allocated around PLN 10 billion in financial support, with 36% of people allocating on average between PLN 100 and 499 per person, and 8% more than PLN 1000. It is worth noting that in the whole of 2021, Poles donated PLN 3.9 billion to charity (PIE, 2022). In addition to financial and in-kind support, 7% of Poles provided accommodation for refugees in their flats and homes. In summary, in 2022, the total value of Poland's support

for Ukraine amounted to PLN 40 billion, of which approximately PLN 10 billion was the cost of arms and ammunition, approximately PLN 6 billion was the cost of social services for refugees, approximately PLN 5 billion was due to educational services, and PLN 10 billion each came from local government bodies and private individuals (donors) (Żółciak, Osiecki, 2023).

Practically on a par with unaffiliated people, non-governmental organisations (NGOs) joined the relief effort. They became active both in the centres of the humanitarian crisis (on the Polish-Ukrainian border and in the border strip) and throughout the country. In the first days of the Russian invasion, their activities were spontaneous and uncoordinated, while already a few days later the first social crisis staffs started to be established to associate the needs of refugees and to improve communication between NGOs, Crisis Management Centres, public administration bodies and local governments (Grabowska, Pięta-Szawara, 2022). Large organisations with a national structure, such as the Polish Humanitarian Action, Caritas Poland, the Polish Red Cross, organisations of Ukrainian citizens, including the Society of Friends of Ukraine, and many others with a local reach, joined the effort and made a significant contribution to providing assistance primarily in the place of their territorial impact.

At this point, it is worth recalling that in Poland in 2020, 95.1 thousand registered non-profit organisations were active (Goś-Wójcicka, 2022). The most numerous group were associations and foundations, of which associations accounted for 66.7 thousand (70.1%) and foundations for 16.0 thousand (16.8%). The next most numerous group were rural housewives' associations - 8.5 thousand entities (8.9%). The number of economic and professional self-government organisations actively operating in 2020 was 2.1 thousand (2.2%), and social religious entities - 1.9 thousand (2.0%). In addition, 94.4 thousand entities belonged to the social economy sector, 9.3 thousand had the status of a public benefit organisation and 0.3 thousand were listed as social enterprises. The largest share of registered non-profit organisations in 2020 was located in the Mazowieckie Voivodeship (15.9%), specifically in the Warsaw Capital Region (10.7%). On the other hand, the smallest proportion of organisations was based in the Opolskie and Lubuskie Voivodeships (2.6% each respectively).

What is the condition of the NGO sector in Poland? Research carried out by the Klon-Jawor Association on the legal, organisational and financial situation of NGOs in 2002-2022 indicates that: - the number of registered organisations is increasing, although at the same time the share of those that are actively operating is decreasing; - the percentage of foundations established is increasing, while that of associations is decreasing; - associations and foundations are increasingly using the support of volunteers, but the number of people willing to do community work is decreasing; - the number of members in NGOs is decreasing; - organisations are increasingly paying for the work done for them; - organisations are increasingly less optimistic in their perception of their operating conditions in the near future (Charycka, Gumkowska, Bednarek, 2022).

What activities have Polish NGOs undertaken in support of refugees? These can be classified into several groups (Dudkiewicz, 2022): - provision of safe shelter for asylum seekers; - support for refugee hosts; - assistance for people with disabilities and dysfunctions; - support for LGBT+ people; - psychological support; - provision of legal aid; - coordination of volunteering; - Polish language teaching and educational counselling; - transportation of refugees; - assistance for animals; - collections of material and monetary donations.

The multifaceted assistance provided by NGOs required immediate action, which in the early days of the immigration crisis was implemented spontaneously, skipping the planning stage. Reality showed the condition of NGOs in the country, which, without waiting for "guidelines", "programmes" and "competitions", proceeded to act. Each to the best of their ability. An avalanche of cordiality and assistance was unleashed: transport, advice, collections. In the first few weeks, the assistance provided to people arriving from Ukraine was "well-organised chaos". As the situation developed, the aid was coordinated and targeted at specific communities and needs. Organisations divided aid tasks according to their scope of action, established cooperation horizontally (among themselves) and vertically (with governmental and local authorities), which contributed to the quality of the aid activities undertaken.

#### **4.2. Assessing the social activity of poles in the area of relief efforts**

Given the civic training that Polish society has undergone over the centuries, it should come as no surprise that Poles rushed to help war refugees with such commitment and comprehensiveness. Nevertheless, as the refugee crisis developed, its scale, form and intensity began to change. As mentioned - in the first period of the conflict, it was mainly the population that rushed to help, activating layers of informal, bonding capital (families, neighbours, work colleagues). As the situation developed, non-governmental organisations (NGOs), both local and national in scope, stepped in, activating the assets of formal, bonding (associational) capital. At the next stage, the number of local and governmental institutions that institutionally took over aid activities gradually increased, and thus the role of social initiatives implemented within the framework of civil society began to diminish.

In retrospect, how do Polish citizens assess the possibility of helping the Ukrainian people? By comparing the data presented in the reports of the Public Opinion Research Centre for the period from May 2022 to April 2023, it is possible to make a certain diagnosis and identify trends in this respect. Thus, the vast majority of Poles (78%) still support Poland's acceptance of Ukrainian refugees. One in seven Poles (14%) is against accepting refugees, and this result also does not change markedly over the period studied. Support for accepting refugees from Ukraine is more often declared by older respondents (86% in the age group of 65 or more against 72% among the youngest respondents (CBOS: May 2002, January 2023, April 2023).

As of May 2022, about half of Poles declared invariably that they or members of their households voluntarily and unpaid help refugees from Ukraine. In January 2023, there was a marked break in this trend, with two in five respondents (41%) declaring that they were helping Ukrainian refugees, which was as much as an 11-point drop compared to December 2022. It can be assumed that this was rather related to the deteriorating economic situation of Polish households, rising food costs and high inflation. All these factors forced Poles to be more frugal, regardless of their attitude towards Ukrainians themselves. The level of declarations of providing assistance to refugees from Ukraine in April 2023 increased slightly - to 46%, an increase of 5 percentage points. However, it is still noticeably lower than the 2022 results, which did not go below the 50% threshold.

As in previous surveys, refugees are more likely to be assisted by people living in larger towns and cities (65% in the largest cities vs. 40% in rural areas), better educated (58% among respondents with tertiary education vs. 37% with basic vocational education) and better at assessing their material conditions (51% among those assessing them as good vs. 36% among those assessing them as bad).

It is worth noting another trend, related to the assessment of the assistance offered by the Polish state to refugees from Ukraine. Namely, the majority of Poles believe (68% in April 2023 vs. 64% in December 2022) that the assistance Poland offers to refugees from Ukraine is sufficient. One in five respondents (22%) thinks it is too much, with this percentage from May 2022 to April 2023 remaining in the 22%-30% range, so this is not an atypical result (Central Statistical Office: May 2022; December 2022; April 2023).

Summarising the attitude of Poles as a whole towards Ukrainian refugees on the basis of the cited opinion polls, it can be concluded that 62% of Poles speak positively about them, every fifth respondent (21%) has an indifferent attitude and only every ninth respondent (11%) considers it negative (CBOS, April 2023).

One more predictor should be a prompt for further research. Namely, the Polish public's assessment of the actions of other countries in the area of assistance to Ukraine. Most positive ratings were obviously given to the attitude presented by Poland itself, followed by actions taken by the United States (82%) and the United Kingdom (65%). Countries at the other extreme are Hungary (54% negative) and Germany (43% negative) (CBOS, April 2023).

## 5. Conclusions

Members of Polish society, when providing comprehensive assistance to people in need, were guided by various factors. The most important ones include a spontaneous reaction to events happening beyond the eastern border of the country, the need of the heart, and the willingness of Poles to help people in need. The foundation of these activities was the

accumulation of social capital, which is a resource formed on the basis of relations and ties between individuals and social entities.

The idea of civil society presupposes the active participation of citizens in the life of the state. This activity is expressed not only in participation in elections to representative bodies, but also - or perhaps above all - in activities that society deems important, relevant and necessary. This motto can be encapsulated in the thesis: where the state cannot, society must.

This is reflected in the actual measures taken for refugees arriving from Ukraine. Before the state, and more specifically the public administration bodies, launched legal, organisational and financial procedures, it was society that was the first to come to the aid. By spontaneously organising help spots at information points at the border, at railway stations and finally in their own homes, they shared material and financial goods and psychological support. It was at this time that the social capital inherent in society became the glue and the foundation on which so much was accomplished for people in existential and emotional crisis.

The Polish people once again showed Europe and the world that in an emergency they can unite, organise from below and act together for the benefit of others and the common good. With the beginning of institutional action, under the aegis of governmental and international institutions, society returned to the mode of everyday action. However, the inherent resources of social capital in society are ready to be used in the next extraordinary event.

After more than a year's experience of war, it can be concluded that refugee assistance is being provided within the institutions of the welfare state system. The state carries out its mission not only for the citizen, but also for those who have found themselves legally on its territory. Hence, war refugees from Ukraine have access to social benefits, the health system or education on the same level and terms as Polish citizens. This requires the coordination of a number of public institutions whose role is to bridge social differences and tensions and to ensure social cohesion between immigrants and the host society.

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## THE ROLE OF SCIENCE PARKS IN POLAND IN THE INTERNATIONALIZATION OF TENANT BUSINESSES

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**Purpose:** The aim of the article is to characterize the internationalization of science parks (STP) from a micro perspective, while the main aim of the research was to diagnose the support for the internationalization process of tenant businesses located in Polish STP in the context of the development phases of these enterprises.

**Design/methodology/approach:** To achieve the theoretical goal, a critical analysis of the literature was carried out. In the empirical layer, own research was carried out using the diagnostic survey method, in which a research technique in the form of an interview was used according to the author's questionnaire. The study was conducted in the second half of 2022 with the participation of management staff from 18 STPs in Poland (55%). The study was complemented by direct interviews with directors of selected STPs conducted in September 2023. The diagnosis of the internationalization status of science parks was made at one of the four possible levels of analysis, i.e. micro, which was analyzed in the following areas: the size of the population of international companies operating in the STP and the scope of support for the internationalization of the STP for companies. For the purposes of the study, four phases of development of STP tenant enterprises were defined and operationalized based on the criteria indicated in the literature on the subject: pre-incubation, incubation, post-incubation and maturity, and their age and size were also taken into account.

**Findings:** The intensity of services provided by the surveyed STPs in supporting the internationalization of enterprises varied. The research results indicated that parks with the highest share of entities in the maturity phase were, on average, characterized by the highest percentage of entities with foreign capital. However, statistical analysis using linear correlation coefficients and rank correlations did not indicate the existence of significant differences between the share of enterprises active abroad and the development phase of enterprises tenants of parks. However, it was confirmed that the activities undertaken by the park were positively and statistically significantly correlated with the share of enterprises active abroad.

**Originality/value:** The result of the study is an understanding of the phenomenon of STP internationalization in Poland at the micro level in the context of the development phases of tenant enterprises, which is an original approach to this issue and the first study of this type conducted in Poland. Although the research confirmed some of the assumed relationships,

some of them were confirmed on the basis of statistical analysis, however, further research should undoubtedly be conducted to take into account other parks operating in Poland, but also to take into account other factors that may determine the process of STP internationalization from a micro perspective.

**Keywords:** internationalization, phase of development, science park, tenant businesses.

**Category of the paper:** Research paper.

## 1. Introduction

Considering the concept of science parks<sup>1</sup> and their organization, contemporary science parks are the most developed type of centres of innovation and entrepreneurship (Allen, 2007; Albahari et al., 2017; Amoroso, Hervàs Soriano, 2019; EARTO, 2015; Lai, Shyu, 2005; Martínez-Vela, 2016; Mażewska, Tórz, 2012; Squicciarini, 2008; Unlü, 2022). The basic mission of science parks is to stimulate the economic development of the region in which they are situated (Luger, Goldstein, 1991). However, in order to pursue their principal mission, they have to incorporate into their classical roles and activities some completely new initiatives, and to create a portfolio of innovative services so as to support the development of tenant businesses (Edler, 2008; ESCAP, 2019; Henriques et al., 2018; Lizińska, 2015; Zacharewicz et al., 2017). A considerable percentage of businesses residing in science parks are knowledge-based companies, which typically implicates a higher degree of innovativeness and technology use than demonstrated by traditional businesses. At the same time, such enterprises are strongly exposed to globalization and its consequences, and somehow ‘forced’ to undergo internationalization in the early years of their existence (Cahen et al., 2017; Zacharewicz et al., 2017).

Tenant businesses who are stakeholders of a science park go through different stages of development, and therefore present different limitations and needs, also in the scope of support to internationalization. It is significant to strengthen the international presence of a science park’s residents (Błaszczuk et al., 2023) because ‘the 21<sup>st</sup> century science park is a gateway and not a destination’ (Allen, 2007, p. 10). Yet, the number of research papers dedicated to this question is limited (Albahari et al., 2019; Błaszczuk et al., 2018; Sobol, 2018b).

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<sup>1</sup> Parks are given different names around the world, like ‘technology park, technopole, research park or science park’ (Link, Scott, 2018). For the sake of this article, we follow the definition by the International Association of Science Parks and Areas of Innovation (IASP), which refers to all of the mentioned organizations, and the STP acronym is used with regard to all of these designations.

The above considerations encouraged us to undertake a study on internationalization<sup>2</sup> of Polish science parks on a micro-level, in the context of phases in the development of tenant businesses, which is an original approach to the research problem.

The purpose of this study has been to explore the issue of support given to the process of internationalization of tenant businesses in Polish science parks, taking into consideration development phases of these businesses. To reach this goal, a review of the subject literature was made, while the empirical part of the research consisted of own quantitative and qualitative studies aimed at obtaining original data.

The article is designed as follows. The next chapter contains a brief review of the literature dealing with the essence of internationalization of science parks on the micro-level, including a discussion of the specific character of tenant businesses. Afterwards, the methods used in the relevant research were presented. In the subsequent chapter, the results of the research were discussed. Finally, conclusions are drawn and the limitations encountered by the authors are mentioned. In addition, some valuable observations regarding future studies are given.

## **2. Literature review**

### **The essence of internationalization of STPs on the micro-level**

Although internationalization is not the goal of all parks (Bengtsson, Löwegren, 2001; Lizińska, Sobol, 2023; Zacharewicz et al., 2017), nowadays it is almost impossible for a science park to be exclusively ‘national’, and to completely ignore the international dimension in its strategies and actions (Lund, 2019). It also needs to be stressed that the strategic decision to go international and consequently to undertake actions for the sake of internationalization, including their effectiveness, depends on various external and internal factors, such as the phase in the lifecycle of a park, specific character of tenant businesses, the park management model, as well as the quality of support provided by business environment institutions (Bigliardi et al., 2006; Cruz-Castro et al., 2015; Guadix et al., 2016; Tomelin et al., 2018). These factors either directly and indirectly shape the type, range and dynamics of activities in a given science park.

M. Wright and P. Westhead (2019) emphasize the need to consider three context-related levels of analysis regarding the operation of a science park: macro- (city, region, country), meso- (science park, incubator, accelerator) and micro-level (a tenant business, a businessman). More precisely, internationalization of a science park on the micro-level can be considered as

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<sup>2</sup> For the purpose of this article, the definition of internationalization is borrowed from concept applied to Public Research Organizations (RTOs), including the internationalization of science parks, which is explained as ‘a process of increasing involvement in international (non-nationally based) operations and actions by the PRO, its sub-units or its employees and an increasing openness of the PRO to ‘non-national’ influences, with the effect of transforming the attributes of the organization and of modifying its resource dependence features’ (Castro et al., 2015, p. 4).

some support in the sphere of internationalization of the operation of a science park's tenant companies (cf. Błaszczyk et al., 2018; Phan et al., 2005). The organizational framework of analysis, as described thus far, reflects the heterogeneity of parks. It is highlighted that internationalization of science parks does not equate to the internationalization of its tenant enterprises.

As regards internationalization on the micro-level, managers of a science park can adopt one of the following strategies for implementation: defensive (attracting companies with foreign capital, which creates opportunities to start cooperative relationships with tenant companies) or offensive (activization and support of tenant companies in internationalization efforts). In practice, managers of science parks usually choose to implement both strategies, but with different intensity or focus (Błaszczyk et al., 2018; Lund, 2019), and the choice of a strategy brings about significant implications, affecting for example the portfolio of innovative services which a science park offers.

Questions pertaining to the internationalization of these organizations on the micro-level can be analyzed in the following areas: size of the population of international companies seated in a science park and the range of support to the internationalization of these companies on behalf of the park<sup>3</sup>. It is common practice for science parks to monitor the internationalization of their tenant businesses (IASP, 2022).

Support to the process of internationalization of companies is an example of innovative services found in portfolios of science parks (IASP, 2017; Laspia et al., 2021; Lecluyse et al., 2019). Manifestation of science parks being active in this area is the assistance given to a company in its preparation for internationalization, such as market research, presentation of opportunities on international markets, advisory services and mentoring (e.g. development of a strategy, preparation of documentation, conducting negotiations, regulations concerning the international transfer of technology and foreign trade, marketing) as well as international programmes (Albahari et al., 2019; Engelman et al., 2015; Franco et al., 2020; IASP, 2022; İmer in., 2021). A science park can actively support resident companies by developing and adjusting the following services:

- international commercialization: organizing conferences, visits and meetings with foreign entities, foreign missions (Guadix et al., 2016; IASP, 2022; İmer in., 2021; UNIDO, 2021);
- partnership in international projects: assistance in finding foreign partners or creating own international network, in which companies should be able to gain access to knowledge and technology and to attract new ventures and customers (Albahari et al., 2019; Engelman et al., 2015; Franco et al., 2020; Lund, 2019; IASP, 2022; Ng et al., 2021; UNIDO, 2021);

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<sup>3</sup> The mentioned areas of analysis of internationalization were presented in the only report so far issued by IASP under the title *Strategigram Analytical Report 2010* as cited in: Błaszczyk et al., 2018.

- international joint venture companies: assistance in the selection and choice of suitable partners for such undertakings (Albahari et al., 2019; IASP, 2022; Tomelin et al., 2018);
- international workforce: development of programmes for attracting talented foreign students, and organizing the selection and training of professional workforce (Zacharewicz et al., 2017).

It is worth underlining that these innovative services offered by science parks in the area of support to internationalization of businesses can be addressed to both domestic and foreign residents. Some parks also offer support of internationalization processes to non-residents of a given park.

### **Enterprises – science park tenants**

Science parks serve a wide range of companies (Lecluyse et al., 2018; Tomelin et al., 2018). According to their organizational characteristics, such as capital origin, size, age, development phase, prevalent branch, etc., tenant businesses can be submitted to basic classification. Among the companies operating in science and technology parks, it is possible to distinguish a group of enterprises with foreign capital (ca 13% of the population). However, the dominant share is composed of local companies (41.4%), regional and national companies (19% and 26.4%, respectively), which reflects the role of science parks as local actors of innovation (IASP, 2022; Theeranattapong et al., 2021). Nearly 85% of businesses situated in science parks are micro- and small companies, while the presence of large companies is rather incidental. There is also a considerable share of young businesses, that is less than 3 years old, in the total number of tenant companies (IASP, 2022). This means that science parks still focus on their main goal, such as supporting start-ups from their onset, for example by providing entrepreneurship incubation and business acceleration, in addition implementing spin-off programmes. Nonetheless, it is possible now to observe a group of science parks that concentrate on supporting and improving the competitiveness of companies with a stable market position, including international ones (Lund, 2019).

Companies based in science parks represent quite a large variety of branches, although the following sectors seem to dominate: ICT, biotechnology, software engineering, energy generation, and artificial intelligence (IASP, 2022). The focus among science parks on specific sectors stems from the criteria adopted for the selection of potential tenant companies (Ng et al., 2017; Ng et al., 2019a), which could be dictated by the following reasons: strengths of the local business community and promoting synergy, the need to develop specific technologies, or certain bonds with specialized higher education institutions (IASP, 2022; Van Winden, Carvalho, 2015). Another important consideration could be the limited area of a park, which means that the park's strategic decision-makers are inclined to prefer companies with the highest growth potential (Chen, Huang, 2004).

An overview of the sectors and specializations seated in science parks demonstrates that a considerable percentage of park residents are companies based on specialized and advanced technologies, including new technology-based firms (NTBF). This class of companies is important and interesting for a number of reasons (cf. Sobol, 2021). NTBFs excel in flexibility and rapid response to a change in the environment (Sobol, 2018a); they also demonstrate strongly innovative and pro-active approaches (Lee et al., 2013; Onetti et al., 2012), and their business offer is characterized by innovativeness and a significant added value (Bell et al., 2003; Knight, Kim, 2009). This means that such companies have the potential to develop their business also outside the home country, but - on the other hand - they are somehow 'forced' to undergo early internationalization in order to become profitable and to develop (Bruneel et al., 2006; Cahen et al., 2017; Coeurderoy, Murray, 2008; Zacharewicz et al., 2017). The indisputable role that these companies play in the development of regions is worth emphasizing (Asc et al., 2003; Audretsh, Keilbach, 2007; Verheul et al., 2009; Hessels, Van Stel, 2011), in addition to their contribution to the promotion of technological change and innovation in many countries (Autio et al., 2000). Companies developing their business around a new technology platform will most probably have influence on globalization, on both the rate of innovation and competitive pressure (Onetti et al., 2012).

Regardless of the dominant branch and specialization, science park residents go through different phases of development, which can also serve as a basis for their classification, that is: entities with business ideas which have not been developed yet (the pre-incubation stage), companies at an early stage of development (incubation stage), and well-established companies (Albahari et al., 2019). Particular stages in the development of a business are distinguished by having a different set of limitations and needs (Chan, Lau, 2005; Ferguson, Olofsson, 2004; Ng et al., 2019b; Ng et al., 2021), and internationalization is a component of post-incubation, understood as the phase of acceleration of a business project, which comprises the activities carried out when a company has achieved operational and financial independence, and is capable of continuing its business activities without external support (FEDER, 2014 as cited in: Franco et al., 2020).

For the management of science parks, it is therefore important to meet the actual needs of tenant companies, including those related to internationalization, and taking into account the specific character of each company (Albahari et al., 2019; Cadorin et al., 2020).



### 3. Methodology

#### Objective and scope of the study

The main objective of this study has been to make a diagnosis of the support given to the internationalization of tenant businesses in Polish science parks, in the context of the development phases these companies are in. The following research questions were put forth, to express the research objective more accurately:

1. What activities in the scope of supporting the internationalization of tenant companies do science parks undertake?
2. What is the structure of tenant companies in Polish science parks related to the phase of their development and some characteristics (age, size)?
3. Are there dependences between the internationalization of science parks on the micro-level and a phase in the development of tenant companies?
4. What changes are expected within the next three years regarding the intensification of the internationalization of tenant companies, and the support they obtain from science parks?

The following research hypotheses were put to test:

H1: The share of companies active on foreign markets increases with the increase in the share of tenant companies in science parks in the consecutive phases of development in a company's life cycle.

H2: The activities undertaken for the internationalization of tenant companies in science parks translate into a higher percentage of tenant companies in a given park active on foreign markets.

The research subject consisted of all 33 active science parks in Poland, as of 1 June 2022. The number of these parks was determined according to the database of centres of innovation and entrepreneurship in Poland maintained by the Polish Business and Innovation Centers Association in Poland (PBICA)<sup>4</sup>. The names of these science parks were not revealed so as to ensure the research respondents' complete anonymity in order to reduce the range of error in responses (Konrad, Linnehan, 1995). The management staff from 18 science parks in Poland (55%) took part in the survey. There was also one reply submitted to the researchers informing that the science park in question could not take part in the survey due to some organizational matters.

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<sup>4</sup> *Stowarzyszenie Organizatorów Ośrodków Innowacji i Przedsiębiorczości w Polsce (SOOiPP)*. Retrieved from: <https://www.sooipp.org.pl/baza-osrodkow>, 1.06.2022.

## Research methods

To achieve the research goal, a review of the subject literature was conducted, while the empirical part consisted of own study aiming at the acquisition of primary data. The authors' intention was to gain a comprehensive insight into the internationalization of science parks on the micro-level, which is why a decision was made to conduct the study in two stages and to employ both quantitative and qualitative research methods.

The first stage of the empirical study was completed in the first half of year 2022. A survey method was used, involving a research technique in the form of a questionnaire developed by the research authors. The aim of the questionnaire was to obtain two categories of information: activities in the area of support to internationalization of tenant businesses in science parks, and the characteristics of science park residents according to these criteria: age, size, development phase, branch or branches represented and the level of internationalization. The analysis included: start-ups and enterprises - stationary tenants of individual PNTs, i.e. excluding companies using a virtual office.

The study results enabled us to express the analyzed problem in figures. The preliminary analysis of the data also shed light on some important aspects which required in-depth studies. It was therefore justified to conduct a qualitative analysis as the second step of the research. Based on the questionnaire, face-to-face conversations were carried out with directors of four selected science parks in Poland. This part of the study took place in September 2023, at the premises of these parks. The results of those interviews provided a valuable supplement to the results of our analysis of the quantitative data, and made a significant contribution to the reliable and professional interpretation of the whole research that followed.

In turn, our diagnosis of mutual dependences between the selected dominant characteristics of tenant companies in parks versus the continuous variables describing the share of companies with foreign capital and the share of companies active on foreign markets was conducted on the basis of an analysis of relationships between the variables and an attempt to determine statistically significant differences between the identified groups of companies.

Due to the small number of observations, the unequal numbers of observations within particular groups of objects, and the lack of a possibility to confirm a normal distribution of the analyzed variables with the use of the Shapiro-Wilk test, it was decided to employ non-parametric versions of tests, identifying the differentiated level of the intensity of the analyzed parameters among the groups. In addition, beside the results of these non-parametric tests, means and medians within particular groups were provided, which facilitated the interpretation of the results. The following levels of significance of the non-parametric tests, i.e. (i) nonparametric equality-of-medians test, verifying if the analyzed populations have the same medians, (ii) Kruskal-Wallis test, which is generalization over a larger number of groups, (iii) two-sample Wilcoxon (Mann-Whitney) rank-sum test, also verifying the distribution of medians between groups (Mann-Whitney, 1947; Wilcoxon, 1945), are given under table 5.

Additionally, as an element of the analysis of the stability of results, verification was conducted using parametric versions of these tests, including *inter alia* differences in means between the groups, using, for example, one-factor ANOVA.

## 4. Results

Activity of science parks depends on the strategy each park has developed and implemented as well as on the number and characteristics of tenant businesses. The data gathered in this study demonstrate that the science parks in Poland vary in terms of the structure of companies they host, including the age and size of these enterprises. Most science parks have a large share of companies operating there for over 3 years. The data do not manifest a large degree of concentration (over 75%) in terms of the size of companies (tab. 1).

**Table 1.**

*Number of parks in terms of tenant structure by age and size of enterprises*

Enterprises' age	Number of parks by tenant structure			
	up to 25 %	26-50 %	51-75 %	above 75 %
up to 3 years	8	5		2
above 3 years		1	6	8
Enterprises' size	up to 25 %	26-50 %	51-75 %	above 75 %
micro-enterprise	4	1	3	5
small enterprise	8	3	3	
medium enterprise	9	1	2	

Source: own study based on research.

The duration of a company's operating in a science park has influence on both the activities undertaken by the park and on the level of development of these companies as the park's tenants. As demonstrated by data achieved in this research, the companies hosted by the science parks in question are in different phases of development. The share of companies in the first and second development phases does not usually exceed 25%. The share of companies in the third and fourth development phases is more varied, but parks where such companies make up no more than 25% of all tenant businesses are still dominant (tab. 2). A larger share of companies in the phase of stabilization and maturity was typically indicated in parks situated in large urban agglomerations, while a large percentage of companies in the incubation and acceleration phases was indicated in science parks from smaller urban centres.

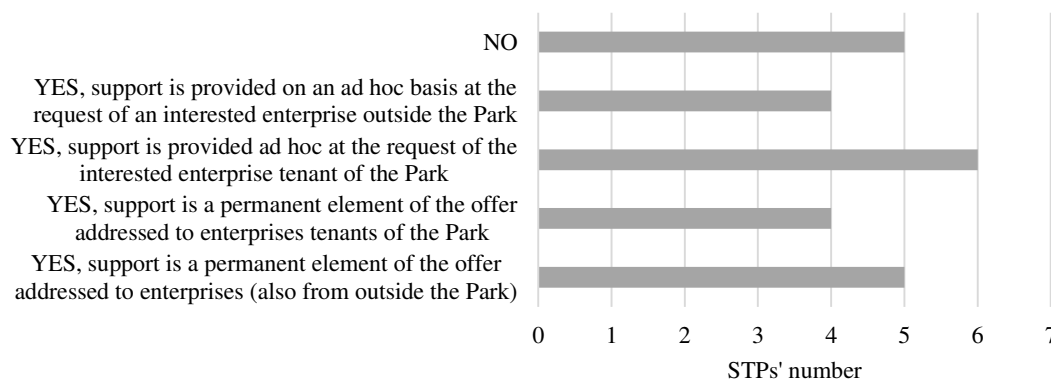
**Table 2.***Number of parks in terms of tenant structure by phase of their development*

Enterprises' phase of development	Number of parks by tenant structure			
	up to 25%	26-50%	51-75%	above 75%
<b>phase 1:</b> incubation (using the services and infrastructure of the Business Incubator under the agreement with the park)	10	1	1	2
<b>phase 2:</b> acceleration (using the park's services and infrastructure on the basis of de minimis aid/scaling programs for start-ups)	10			1
<b>phase 3:</b> stabilization (strengthening market position/cooperation network/customer portfolio)	6	4	3	
<b>phase 4:</b> maturity (ready to function outside the park)	8	3	1	3

Source: own study based on research.

The diverse level of development of companies which are tenants in science parks is quite natural as science parks usually host a variety of companies, from start-ups, including new technology-based firms up to international companies (Albahari et al., 2019; Bengtsson, Löwegren, 2001; Franco et al., 2020; Ng et al., 2021; Tomelin et al., 2018). This, however, gives rise to certain implications for the park's policy. The activities pursued by a park will be equally diverse and adjusted to the possibilities and needs of its tenant businesses.

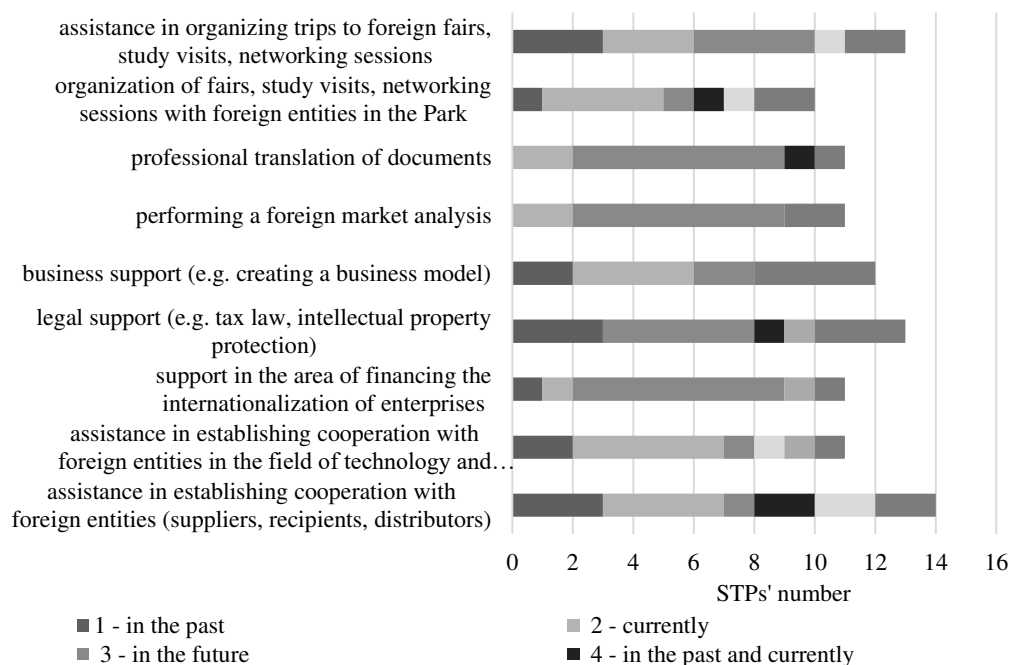
As the research results implicate, the intensity of advisory services provided by science parks in the field of internationalization of companies varied (fig. 1). Some parks did not offer such services at all, others did so occasionally, and in five parks such support was a permanent component of the offer addressed to businesses (also outside the park).

**Figure 1.** Consulting services offered by STPs in the field of internationalization of enterprises.

Source: own study based on research.

Considering the time perspective, many activities are yet in the sphere of planning (including the support to financing internationalization of companies, making an analysis of a foreign market or providing professional translation of documents). Among the activities which were carried out in the past but then discontinued, the following were indicated most often: assistance in starting cooperation with foreign entities (suppliers, buyers, distributors), legal support (including tax law, intellectual property protection) and help in organizing trips

to trade fairs abroad, study visits, networking sessions. At present, the parks carry out mainly such activities that aim to help companies to embark on cooperation with foreign enterprises in technology, research, business support (e.g. creating a business model), and to organize trade fairs, study visits and networking sessions with foreign businesses in the park (fig. 2).

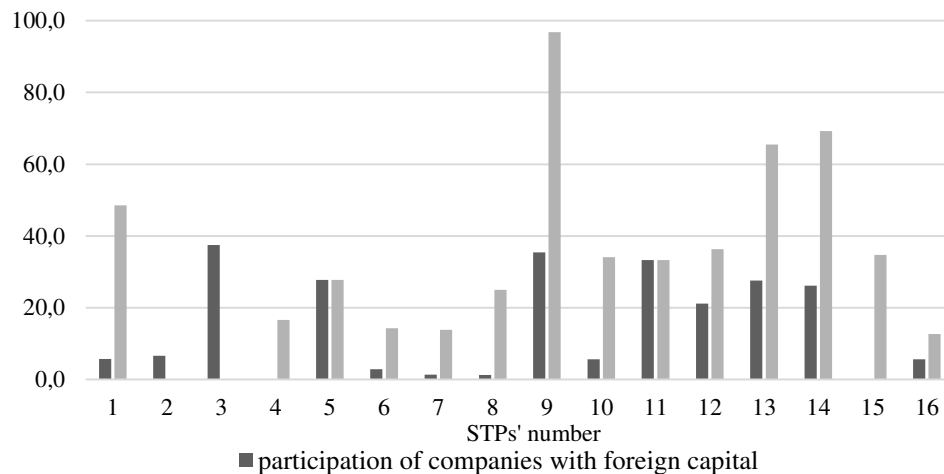


**Figure 2.** Activities carried out by STPs in the area of supporting the internationalization of enterprises. Source: own study based on research.

A compilation of various factors can determine, to various degrees, the specific character of a given park regarding the level of forms of internationalization of tenant businesses.

As the subject literature implicates (Bengtsson, Löwegren, 2001; Lizińska, Sobol, 2023; Zacharewicz et al., 2017), not all parks define it as their aim to promote and achieve internationalization (of a park or its tenants), even though – as underlined by Lund (2019) – internationalization is essential in the current economic conditions. This may also result from the different phase of a lifecycle that is characteristic for parks in Poland (Lizińska, Sobol, 2023).

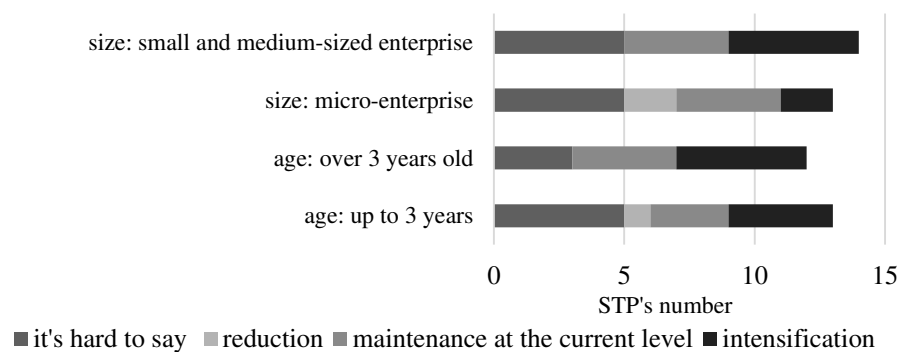
As the results of this study implicate, there are two groups of businesses to distinguish: companies with foreign capital and companies active abroad, which differed in both their absolute number, a finding also reported by others (Błaszczyk et al., 2018; Lund, 2019), and in their share relative to the entire set of companies established in a science park (fig. 3). Companies with foreign capital, owing to their specific character, will definitely find it easier to establish international contacts and gain access to foreign markets. Such diverse shares of the above-mentioned groups of companies among tenant businesses in science parks can be dictated by actions taken by science park managers that may stimulate the process of internationalization, but they can also depend on the specific character of each park, and on the level of development of both tenant companies and the park itself.



**Figure 3.** Share of companies with foreign capital and companies active abroad in the surveyed STPs.

Source: own study based on research.

Science park managers attribute a more intensive internationalization process of tenant businesses to large companies with longer history. However, the survey respondents admitted it was difficult to identify the direction and intensity of changes, particularly with respect to small companies with shorter history of operating in a science park (fig. 4).



**Figure 4.** Assessment of the intensity of changes in the level of internationalization of tenant enterprises according to specific features over the next 3 years in the opinion of STPs' representatives.

Source: own study based on research.

The respondents pointed to some characteristics of tenant companies, indicating the frequency of their occurrence on a quantile scale (cf. column 1, tab. 3). Only the indications given by science park managers that described the companies most numerous among their park's tenant businesses were submitted to further analysis. This approach enabled us to classify the parks into one of the several groups of parks, separately for each of the characteristics considered (phase in the development of a company, the company's age and its size). Data contained in table 3 give a synthetic description of the research sample.

**Table 3.***Distribution of the enterprises operating in scientific parks by their main characteristics*

Enterprises' phase of development			Enterprises' age			Enterprises' size		
Category	%	N	Category	%	N	Category	%	N
1 - incubation	25.0	4	< 3 years	18.75	3	micro	43.75	7
2 - acceleration	12.5	2	>= 3 years	81.25	13	small	31.25	5
3 - stabilization	37.5	6				medium	25	4
4 - maturity	25.0	4						
Total	100.0	16	Total	100.0	16	Total	100.0	16

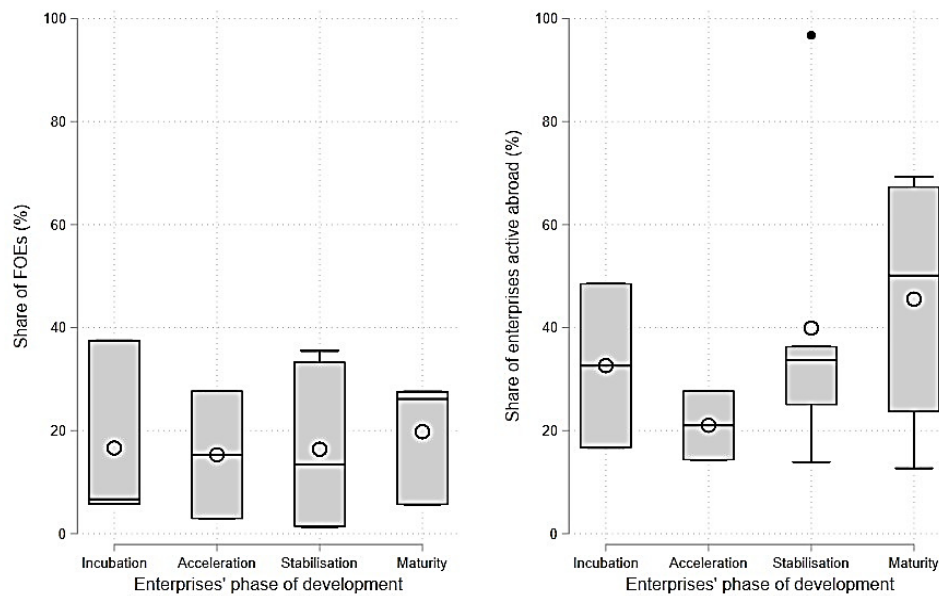
Source: own study based on research.

Science parks with a larger share of companies operating on the market for a longer time (i.e. more than 3 years) more frequently hosted companies in the third and fourth phase of development. On the other hand, science parks distinguished by a larger percentage of younger business entities more often hosted companies in the first and second phase of development.

The distribution of replies from the science park managers regarding the share of companies with foreign capital (left-hand panel) and the share of companies active abroad (right-hand panel) is displayed in figure 5. In this box plot, the mean value was denoted by a circle, the median by a horizontal line in a rectangle, and the maximum and minimum values by horizontal lines located in the uppermost or lowermost positions (so-called whiskers). In turn, outliers were marked with shaded dots. The highest variation in answers relative to the above groups was observed in the right-hand panel for the maturity phase, and the lowest one was noted for the acceleration phase. An evident outlier in the stabilization phase located also in the right-hand panel is worth noticing.

Analysis of data illustrated in fig. 5 reveals the highest average level of internationalization of science park tenant companies in the maturity phase, followed by those in the stabilization phase, and finally in the incubation and acceleration phases. Likewise, parks distinguished by the highest percentage of companies in the maturity phase were characterized by the highest average percentage of companies with foreign capital share, although – same as in the aforementioned case – this change did not follow a linear course.

Analysis of data obtained from non-parametric tests (tab. 4) does not provide the ground for verifying the occurrence of significant differences in the values of medians illustrating: (1) the share of companies with foreign capital, and (ii) share of companies active abroad, versus the developmental phase that the tenant companies were in. However, the verification of the results from non-parametric tests with the outcome of the one-factor ANOVA test applied to analyze means between the groups proved the lack of statistically significant differences.



**Figure 5.** Distribution of variables of interest by phases of enterprises' development.

Source: own study based on research.

**Table 4.**

*Share of FOEs and share of enterprises active abroad by the phase of enterprises' development*

Phase	Share of FOEs (%)			Share of enterprises active abroad (%)		
	Mean	Median	N	Mean	Median	N
1 - incubation	16.63	6.67	3	32.62	32.62	2
2 - acceleration	15.32	15.32	2	21.03	21.03	2
3 - stabilization	16.39	13.45	6	39.91	33.71	6
4 - maturity	19.79	26.15	3	45.53	50.11	4
Total	17.02	13.94	14	37.78	33.71	14
Median test p-val	0.881			0.392		
Kruskal-Wallis test p-val	0.903			0.707		

Note. p-val values below 0.1 indicate significant differences in the distribution of the analyzed variables between the identified groups of enterprises. Otherwise, these tests indicate statistically insignificant differences in the level of medians (equality of distribution function) between the above-mentioned. identified groups. The Kruskal-Wallis test is considered a nonparametric alternative to one-way ANOVA.

Source: own study based on research.

The identification of correlations between the level of internationalization of tenant companies and the dominant phase in their development was verified with the help of correlation coefficients, and linear regression models were constructed to further visualize the tested dependences (fig. 6). Levels of the linear correlations and rank correlations (which do not require a normal distribution of variables) are given in table 6. Their results (especially the coefficients of the Spearman and Kandall correlations) do not allow us to determine any statistically significant correlation between the selected measures of the internationalization of companies (here, the share of companies) and the dominant development phase. In the case of all measures shown in this study, the achieved correlation coefficients were not significant statistically. Thus, the results do not attest to the validity of hypothesis 1.



This outcome might have been influenced by a number of factors illustrating both the background conditions in which the companies in particular science parks operate, the extent and success of the actions that these parks' managers undertake to support their tenant businesses' internationalization, the branches in which these companies operate, or the willingness to take risks by the managerial personnel of these companies.

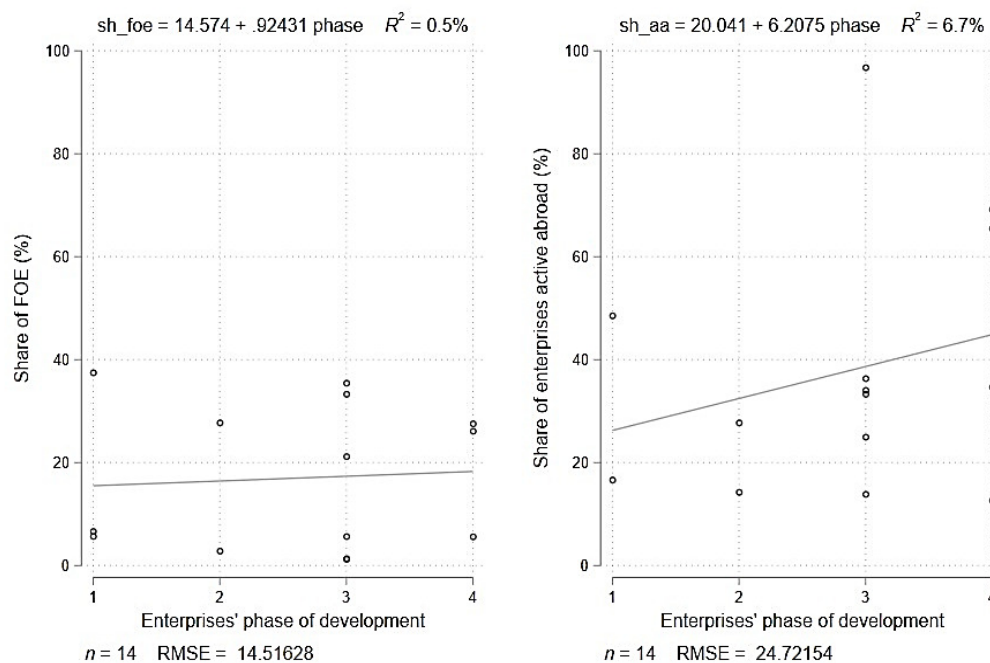
**Table 5.**

*Correlations between internationalisation measures and enterprises' phase of development*

Correlation measure	Share of FOEs vs. enterprises' phase of development		Share of enterprises active abroad vs. enterprises' phase of development	
	Coefficient	p-val	Coefficient	p-val
Pearson's	0.072	0.808	0.259	0.371
Spearman's	-0.106	0.717	0.228	0.434
Kandall's tau-a	-0.076	0.727	0.153	0.449
Kandall's tau-b	-0.088	0.727	0.178	0.449

Source: own study based on research.

The estimated linear regressions (fig. 6) confirmed a small fit of the curve equations and the data ( $R^2$ ).



**Figure 6.** Visualization of the relationship between the dominant enterprises' phase of development and the level of enterprise internationalization.

Source: own study based on research.

Furthermore, the fit for companies active abroad (the right-hand panel) was higher than that of companies with foreign capital (the left-hand panel). Also in this case, the coefficient standing at the phase of development of companies was higher, which means that as the share of companies in a higher development phases increases, an average percentage of companies active abroad increases too. The relationship between the share of companies with foreign capital and the development phase is less obvious, and the collected data do not provide

evidence to fully identify this relationship. Nevertheless, in both cases, a higher number of observations might allow one to determine more precisely the course of relationships between the categories submitted to analysis.

The results obtained in our study could be connected to the diverse pathways set by the internationalization processes that companies go through. Companies with a share of foreign capital have greater opportunities to enter higher phases of internationalization right from the start of their existence. As for other companies, launching different actions on a foreign market can more often occur in a sequence, characteristic for the Uppsala model. This may often require some support from the host park, but it could also be conditioned by the development phase in which a given company is.

The search for characteristics differentiating the level of internationalization of companies encouraged us to verify dependences between the variables describing companies, i.e. age of a company, its size, and actions taken by the science park in the realm of corporate internationalization. Among the analyzed categories, only the actions undertaken by the park were positively and statistically significantly correlated with the percentage of companies active abroad, which means that the parks offering services in the field of business internationalization had a higher share of companies active abroad (tab. 6).

**Table 6.**

*Spearman's correlations between selected enterprises' characteristics*

Category	Share of FOEs		Share of enterprises active abroad	
	Coefficient	p-val	Coefficient	p-val
Enterprises' age	-0.065	0.826	0.310	0.281
Enterprises' size	0.295	0.305	0.284	0.325
Does the park offer consulting services in the field of enterprise internationalization (yes/no)?	0.194	0.506	0.628	0.016

Note. The table presents Spearman's rank correlation coefficients due to the specificity of the analyzed data.

Source: own study based on research.

This was a factor that unambiguously differentiated the share of companies active on foreign markets between science parks, which can implicate positive effects of measures implemented for the sake of supporting internationalization of tenant companies in science parks (in view of the positive correlation coefficient). The research outcome allows us to confirm the second research hypothesis, claiming that actions undertaken by science parks to support internationalization of tenant businesses translate into a higher average percentage of companies residing in science parks that are active on foreign markets. Due to the small size of the research sample, an attempt to deepen the above analysis, for example by focusing on particular type of actions (i.e. which actions most contribute to greater internationalization) was impossible and would call for further survey studies. Also, an attempt to determine the causality and direction of this causality for the analyzed phenomenon would necessitate obtaining more data from companies, which should cover several years of their operation on the market.

## 5. Summary

The conducted research made it possible to characterize the parks in terms of the characteristics of the tenant enterprises operating there. The research results indicated that the structure of these enterprises varies in terms of age and size of enterprises. This situation is undoubtedly related not only to the development of enterprises, but also to the creation and development of the parks themselves. There are enterprises in various stages of development in the studied parks. A greater share of enterprises in the stabilization and maturity phase was most often characteristic of parks located in large urban agglomerations, while a greater share of enterprises in the incubation and acceleration phases was more often indicated in parks located in smaller urban centers.

The factor that may determine the development of tenant enterprises, not only on the domestic market, but also internationally, is support from parks. The intensity of advisory services provided by the surveyed parks in the field of enterprise internationalization varied. Unfortunately, some parks did not offer such services in general, some did so on an ad hoc basis, while only in a few parks support is a permanent element of the offer addressed to enterprises. At the same time, many activities are still in the planning stage.

The two groups of entities identified in the research (companies with foreign capital and companies active abroad) were characterized not only by their absolute number, but also by their share in relation to all park companies. The research results indicated that parks with the highest share of entities in the maturity phase had, on average, the highest percentage of entities with foreign capital. However, the statistical analysis did not indicate any significant differences between the share of enterprises active abroad and the stage of development of enterprises tenants of parks. This situation may have many causes. These include the varied conditions in which enterprises operate in parks, the activity of parks, and the specificity of the enterprises themselves. In the case of the share of enterprises active abroad, their share increased with the increase in the share of enterprises at a higher stage of development, but this relationship was not at a statistically significant level. However, it was confirmed that the activities undertaken by the park were positively and statistically significantly correlated with the share of enterprises active abroad. The research and its results confirmed some of the assumed relationships, some of them were confirmed on the basis of statistical analysis, but further research should undoubtedly be conducted to take into account other parks operating in Poland, but also to take into account other factors that may determine the internationalization process.

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## MEASUREMENT AND TAXONOMY OF COUNTERPRODUCTIVE WORK BEHAVIORS

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**Purpose:** The aim of the article is to identify the dimensions of counterproductive work behaviors.

**Design/methodology/approach:** The article presents results of a questionnaire-based survey conducted among 385 working students of a private college of higher education in July 2021. The starting point was division into five categories of counterproductive work behaviors. The dimensions have been investigated in an iterative process.

**Findings:** An important conclusion is certain departure from the recreated dimensions in comparison with the five-factor model of counterproductive behaviors proposed by Spector. Thus, there appears physical aggression as a separately interpreted factor.

**Research limitations/implications:** Participation in the survey was voluntary. This limits representativeness. It is worth drawing attention to the basic limitation of this research, which is changeability of organizational behaviors at the time of connecting them with, among others, social acceptance (or a lack of such acceptance) or encouragement (or a lack of encouragement) of counterproductive work behaviors.

**Social implications:** A disregard for societal norms leads to antisocial behavior. All described behaviors contain a degree of malevolency that directly affects interpersonal behavior.

**Practical implications:** Measurement and taxonomy of the multifaceted, negative phenomenon which detrimental behaviors in organizations are, seem indispensable in order to work out effective methods of preventing such acts. This will have a flow-on effect in regards to performance at work.

**Originality/value:** Original contribution of the content to the body of knowledge. The results of this study encourage further discussion on physical aggression as a separately interpreted factor.

**Keywords:** Counterproductive Work Behavior, dimensionality of counterproductivity.

**Category of the paper:** Research paper.

## 1. Introduction

Measurement and taxonomy of the multifaceted, negative phenomenon which detrimental behaviors in organizations are, seem indispensable in order to better recognize the problem and work out effective methods of preventing such acts. In their different conceptions, researchers propose a diverse number of their dimensions (Baka et al., 2015; Gruys, Sackett, 2003; Salgado, 2002; Spector et al., 2006; Wiernik, Ones, 2018; Bruk-Lee, Spector, 2006; Penney, Spector, 2005; Fox et al., 2001; Barbaranelli et al., 2013).

As regards research on detrimental behaviors at work so far, different approaches have been used:

Individual negative acts, e.g. theft (Greenberg, 1990), brusque attitude towards customers and the like, were examined (Perlow, Latham, 1993),

Similar behaviors were grouped in types, such as deviation-like behaviors at work (Robinson, Bennett, 1995), organization-directed aggression (Neuman, Baron, 1998).

A drawback to the above-presented frameworks of behaviors is their narrow theoretical context and the lack of possibility of generalizing relevant research results to transfer them onto other areas of detrimental behaviors in organizations.

Facing the above, in order to define the behaviors in question, researchers use a broader term – Counterproductive Work Behavior (CWB), which – in the opinion of authors – refers to acts intended to do harm to the organization. In the form of abuse, such behaviors can – to an equal degree – do harm to persons – stakeholders of organizations, as well as take the form of deviation in production, sabotage, theft or worker's withdrawal and then – as such – be detrimental to the organization (Spector et al., 2006).

It has been proven that various types of harmful behaviors clearly correlate with one another. Hence, a five-factor model of counterproductive behaviors has been elaborated. Below, we present a short characteristic of the factors distinguished by Spector and his colleagues (Spector et al., 2006):

- Abuses – their aim is to do physical or psychological harm to shareholders of the organization. On the basis of data collected from their focus research, Richman et al. (2001) distinguished five types of acts of abuses committed by workers – physical aggression (e.g. beating, pushing), verbal aggression (e.g. shouting, calling names), offensive behaviors (e.g. humiliation, offensive gestures), ostracism (e.g. isolating persons, neglecting a person's contribution), instigating (e.g. forcing persons to perform dangerous or prohibited actions). Abuses can consist in active (taking action) or passive (failing to assist) hurting another person.

- Sabotage and production deviation – the aim of these two types of counterproductive behaviors is to harm the organization as a whole. The differences between them consist in the fact that the former (sabotage) is an active form of CWB and manifests itself in such actions as (Chen, Spector, 1992): destruction of the employer's property, damage to company equipment, purposeful making workplace dirty, using up larger amounts of material than necessary, e.g. for private use, creating a negative image of the company. In turn, deviation is included in the passive forms of CWB and its manifestations are harder to recognize, as they consist in the following: not complying with recommendations and procedures binding in the organization, conscious making mistakes, intentional lowering of productivity and quality of work, executing work and duties with very low effectiveness and not reporting problems or acts of misuse in the workplace to the superiors (Hollinger, 1986).
- Theft – similarly as sabotage and production deviation, stealing is categorized as manifestation of detrimental behavior towards the organization as a whole (Neuman, Baron, 1998). Here a series of sources of theft can be identified, beginning with demographic factors (Baumol, 1990), factors which stem from the work environment, that is poorly functioning system of control and supervising workers (Hollinger, Clark, 1983) and also personality traits, such as characteristics of the so-called dark triad: Machiavellianism, narcissism and psychopathy (O'Boyle et al., 2012).
- Worker's withdrawal, in other words – “purposeful doing nothing” (Bańka, 2011) which consists in limiting the energy spent on work and shortening time devoted to performing professional duties, prolonging breaks, leaving workplace (Spector et al., 2006), intentional executing work at a slower rate, taking days off which workers are not entitled to, simulating sickness, ‘virtual idleness’ – surfing the Internet during working hours (Lim, Chen, 2009).

The five-factor model of counterproductive behaviors proposed by Spencer et al. is widely known and applied, still the literature on the subject also inclines towards considering models of a lower number of factors (Wiernik, Ones, 2018; Carpenter et al., 2021; Zubaidah et al., 2019). For instance, studies by Baka et al. (2015) suggest a three- or four-factor model; in turn, Italian validation research has distinguished two notionally broader factors, that is counterproductive behaviors towards the organization and counterproductive behaviors towards people (Barbaranelli et al., 2013).

Taking the above into account, the aim of this article is to identify the dimensions of counterproductive behaviors on the basis of results of own research. The authors put forward the thesis that the model of counterproductive behaviors, which emerges as a result of own studies, will be based on fewer than five dimensions.

## 2. Methods

The authors embarked on learning opinions of people who are professionally active and represent organizations of different types. To achieve the goal a survey research was conducted with the use of *CAWI (Computer-Assisted Web Interviewing)* among working students of a private college of higher education in July 2021. The relevant link to the survey was sent to students' addresses via an e-learning platform. Upon clicking the link, students accessed the on-line questionnaire form. The respondents were requested, at the same time, to pass the questionnaire on to other professionally active people. In this way, the 'snowball' effect was obtained, which consisted in recruitment of respondents with the help from other participants (Castillo, 2009).

In order to measure the perception of counterproductive behaviors, an 11-grade measurement scale was used, by means of which the choice of intensity of a feature was to be made between its two opposite characteristics (from 0 – the behavior is not negative up to 10 – the behavior is very negative). The psychometric properties of the tool were checked as far as its reliability was concerned with the use of Cronbach's alpha as well as the exploratory factor analysis (EFA). The calculations were executed in STATISTICA program. Cronbach's alpha can take values from 0 to 1, still the greater the value of Cronbach's alpha, the greater the reliability of the scale. The literature on the subject accepts different desired values of this statistic (generally at least 0.7, although the authors occasionally accept 0.6 as the border value) (Ramli, 2019; Taber, 2018; Siswanti et al., 2020).

## 3. Results

There were altogether 385 persons, including 153 men (39.7%) and 232 women (60.3%) who took part in the survey. The majority of respondents were people in the age up to 38 years: 15.6% of the subjects represented the age group 18-23 years, while 50.1% of the questioned belonged to that of 24-38 years. As regards the level of education, 38.4% of the respondents held secondary education, 6.8% - post-graduate secondary education, 31.2% - Bachelor degree, and 23.6% - Master degree. The substantive questions asked in the questionnaire dealt with counterproductive behaviors at the current workplace (the respondents were asked about the length of their employment at the present workplace).

After carrying out the research, evaluation of the cohesion of the construct was made, as well as its components (dimensions) were pointed to. The statistical parameters of the 21-item version of the tool was assessed (reliability measured with Cronbach's alpha amounted to 0.944). The starting point was division into five categories of counterproductive behaviors as distinguished by Spector et al. (2006). Table 1 presents reliability coefficients (internal agreement) for individual categories (dimensions).

**Table 1.**  
*Internal agreement*

Specification	No. of items	Cronbach's alpha	
Abuses	5	0.625	0.944
Sabotage	5	0.873	
Theft	1	-	
Production deviation	4	0.837	
Worker's withdrawal	8	0.932	

Source: own elaboration on the basis of conducted research.

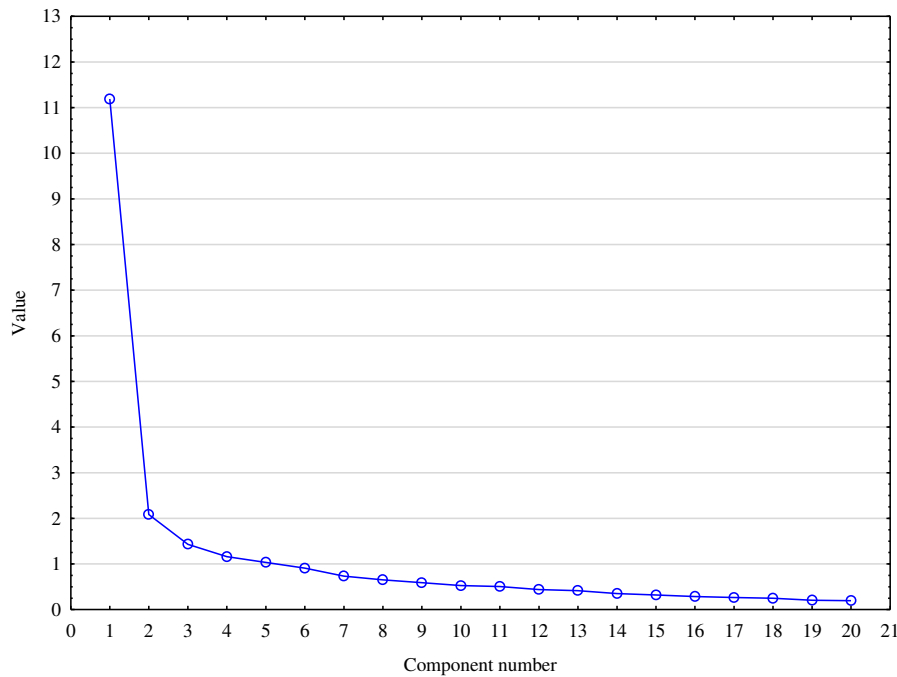
Cronbach's alpha defines cohesion of the items being components of the given scale. It needs remarking, though, that one of statements on the scale measuring abuses ("How negative, it seems to you, is a worker's act of using physical aggression, e.g. beating, pushing?") proved not correlated (coefficient of correlation 0.04; Cronbach's alpha: for the scale including this item 0.625, on removing the item 0.726). However, taking into account the theoretical foundations, despite the medium-satisfying indexes obtained for the scale measuring abuses (Cronbach's alpha 0.625), it was decided that the 21-item version of the tool should be maintained for further analyses.

To establish the number of factors, Kaiser criterion were applied (Table 2) as well as a scree test with analysis of break point (Figure 1). Kaiser criterion recommends retaining factors possessing eigenvalues greater than one. This points to the fact that one can keep five factors (main components), whereas the scree test suggests retaining rather two, three or four factors.

**Table 2.**  
*The Kaiser criterion*

Value	Eigenvalue	% of total variance
1	11.19	46.63
2	2.08	8.68
3	1.43	5.97
4	1.16	4.84
5	1.03	4.31
6	0.91	3.79

Source: own elaboration on the basis of conducted research.



**Figure 1.** The scree plot.

Source: own elaboration on the basis of conducted research.

Distinguishing five factors with the use of the method of main components on the basis of Kaiser criterion did not yield satisfying effects (Table 3) – the picture of the factor structure was not readable to the end. The factor loadings were high in a few factors at the same time (e.g. for the purposeful lowering of productivity and quality of work, intentional making the workplace dirty, intentional being late for work).

**Table 3.**

*Model 1 (5 factors), factor extraction method: Principal Components Analysis; rotation method: Varimax*

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
physical aggression (e.g. beating, pushing)	0.04	0.01	-0.03	-0.01	0.91
verbal aggression (e.g. shouting, calling names)	0.17	0.55	0.26	-0.16	0.33
offensive behaviors (e.g. humiliating, offensive gestures)	-0.03	0.62	0.40	0.18	0.12
ostracism (e.g. isolating persons, neglecting a person's contribution)	0.15	0.74	0.04	0.22	-0.02
instigating (e.g. persuading to do dangerous or prohibited acts)	0.14	0.79	0.16	0.21	-0.02
purposeful lowering of productivity and quality of work	0.47	0.46	0.43	-0.22	-0.12
performing work with poor effectiveness	0.47	0.35	0.27	0.22	-0.16
not complying with recommendations and binding procedures	0.56	0.37	0.17	0.35	-0.10
conscious making mistakes	0.36	0.33	0.52	0.36	-0.08
not reporting problems or acts of abuse at the workplace to superiors	0.38	0.30	0.04	0.73	-0.09
destroying (completely) the property belonging to the employer	0.17	0.14	0.89	0.12	0.02
damaging (to a degree) the equipment	0.24	0.34	0.71	0.16	-0.12



Cont. table 3.

using up a greater amount of materials than necessary	0.49	0.25	0.27	0.63	-0.02
intentional making the workplace dirty	0.27	0.18	0.54	0.65	0.01
creating a negative image of the firm	0.43	0.05	0.63	0.36	0.02
intentional lateness for work	0.47	0.03	0.51	0.44	0.02
shortening the working time	0.75	0.08	0.22	0.27	0.02
prolonging breaks	0.83	0.16	0.10	0.32	0.06
leaving the workplace	0.66	0.14	0.19	0.41	0.07
intentional performing work more slowly	0.78	0.11	0.40	0.14	0.02
taking unscheduled days off work, e.g. due to having drunk alcohol	0.80	0.06	0.11	0.01	-0.04
simulating sickness	0.76	0.11	0.28	0.24	0.05
surfing the Internet during working hours, the so-called virtual loafing	0.83	0.08	0.13	0.22	0.01
appropriation of employer's property	0.34	-0.06	0.47	0.62	0.09

Source: own elaboration on the basis of conducted research.

An analysis of the content of the statements included in the five factors allowed giving them the following names:

- Factor 1 – with reference to the five-item classification proposed by Spector – stands the closest to worker's withdrawal.
- Factor 2 – with reference to the five-item classification proposed by Spector – stands the closest to abuse.
- Factor 3 – with reference to the five-item classification proposed by Spector – stands the closest to sabotage.
- Factor 4 – not reporting problems or acts of misuse in the workplace to superiors.
- Factor 5 – physical aggression (the factor includes only one statement).

In successive steps, it was checked whether there exists a factor structure which could explain the phenomenon of counterproductive behaviors in a less complex manner. Due to the fact that the scree test suggested retaining fewer than five factors, and – at the same time – the results of the exploratory factor analysis were not satisfying upon accepting five distinguished factors, it was decided to analyze alternative models (Table 4, Table 5, Table 6). In the case of the 5-factor model, the participation of the explained variation amounted to 70.4%, for the 4-factor model – 66.15, for the 3-factor one – 61.3%, whereas for the 2-factor model – 55.3%, respectively.

**Table 4.**

*Model 2 (4 factors), factor extraction method: Principal Components Analysis; rotation method: Varimax*

Item	Factor 1	Factor 2	Factor 3	Factor 4
physical aggression (e.g. beating, pushing)	0.11	0.04	0.02	-0.28
verbal aggression (e.g. shouting, calling names)	0.18	0.58	0.22	-0.26
offensive behaviors (e.g. humiliating, offensive gestures)	-0.01	0.63	0.41	0.11
ostracism (e.g. isolating persons, neglecting a person's contribution)	0.15	0.73	0.05	0.24

Cont. table 4.

instigating (e.g. persuading to do dangerous or prohibited acts)	0.15	0.79	0.16	0.22
purposeful lowering of productivity and quality of work	0.44	0.49	0.35	-0.22
performing work with poor effectiveness	0.46	0.36	0.27	0.22
not complying with recommendations and binding procedures	0.57	0.36	0.20	0.34
conscious making mistakes	0.36	0.34	0.55	0.29
not reporting problems or acts of abuse at the workplace to superiors	0.41	0.27	0.15	0.71
destroying (completely) the property belonging to the employer	0.17	0.18	0.89	-0.03
damaging (to a degree) the equipment	0.23	0.36	0.70	0.09
using up a greater amount of materials than necessary	0.53	0.23	0.37	0.55
intentional making the workplace dirty	0.30	0.17	0.64	0.52
creating a negative image of the firm	0.45	0.07	0.68	0.22
intentional lateness for work	0.49	0.04	0.58	0.32
shortening the working time	0.76	0.09	0.26	0.19
prolonging breaks	0.85	0.16	0.15	0.25
leaving the workplace	0.69	0.13	0.25	0.31
intentional performing work more slowly	0.79	0.13	0.41	0.05
taking unscheduled days off work, e.g. due to having drunk alcohol	0.79	0.07	0.10	-0.02
simulating sickness	0.77	0.12	0.31	0.15
surfing the Internet during working hours, the so-called virtual loafing	0.84	0.08	0.16	0.15
appropriation of employer's property	0.39	-0.07	0.57	0.47

Source: own elaboration on the basis of conducted research.

An analysis of the content of the statements included in four factors (Table 4) allowed giving them the following names:

- Factor 1 – worker's withdrawal.
- Factor 2 – abuses.
- Factor 3 – sabotage and theft.
- Factor 4 – not reporting problems or acts of misuse in the workplace to superiors.

In the case of the 4-factor model, physical aggression turned out not to be correlated with any of the four factors. As regards some items (e.g. "purposeful lowering of productivity and quality of work", "using a greater amount of materials than necessary"), factor loading distribution is even on both factors, not dominating strongly in one of the factors only.

**Table 5.**

*Model 3 (3 factors), factor extraction method: Principal Components Analysis; rotation method: Varimax*

Item	Factor 1	Factor 2	Factor 3
physical aggression (e.g. beating, pushing)	0.07	0.07	-0.11
verbal aggression (e.g. shouting, calling names)	0.13	0.62	0.06
offensive behaviors (e.g. humiliating, offensive gestures)	-0.01	0.65	0.38
ostracism (e.g. isolating persons, neglecting a person's contribution)	0.20	0.70	0.11
instigating (e.g. persuading to do dangerous or prohibited acts)	0.19	0.77	0.21
purposeful lowering of productivity and quality of work	0.39	0.55	0.20
performing work with poor effectiveness	0.48	0.36	0.32
not complying with recommendations and binding procedures	0.61	0.34	0.30

Cont. table 5.

conscious making mistakes	0.38	0.36	0.60
not reporting problems or acts of abuse at the workplace to superiors	0.51	0.20	0.42
destroying (completely) the property belonging to the employer	0.11	0.27	0.78
damaging (to a degree) the equipment	0.20	0.42	0.65
using up a greater amount of materials than necessary	0.59	0.21	0.54
intentional making the workplace dirty	0.35	0.18	0.79
creating a negative image of the firm	0.44	0.11	0.70
intentional lateness for work	0.50	0.07	0.65
shortening the working time	0.77	0.10	0.30
prolonging breaks	0.87	0.15	0.22
leaving the workplace	0.71	0.13	0.34
intentional performing work more slowly	0.76	0.16	0.37
taking unscheduled days off work, e.g. due to having drunk alcohol	0.77	0.09	0.07
simulating sickness	0.77	0.14	0.33
surfing the Internet during working hours, the so-called virtual loafing	0.85	0.09	0.19
appropriation of employer's property	0.42	-0.06	0.72

Source: own elaboration on the basis of conducted research.

An analysis of the content of the statements included in three factors (Table 5) allowed giving them the following names:

- Factor 1 – worker's withdrawal.
- Factor 2 – abuses.
- Factor 3 – sabotage and theft.

In the case of the 3-factor model, physical aggression turned out not to be correlated with any of the three factors. As regards some items (e.g. "using up a greater amount of materials than necessary"), factor loading distribution is even on several factors, not dominating strongly in one of the factors only.

**Table 6.**

*Model 4 (2 factors), factor extraction method: Principal Components Analysis; rotation method: Varimax*

Item	Factor 1	Factor 2
physical aggression (e.g. beating, pushing)	0.01	0.00
verbal aggression (e.g. shouting, calling names)	0.08	0.54
offensive behaviors (e.g. humiliating, offensive gestures)	0.08	0.75
ostracism (e.g. isolating persons, neglecting a person's contribution)	0.16	0.62
instigating (e.g. persuading to do dangerous or prohibited acts)	0.17	0.73
purposeful lowering of productivity and quality of work	0.38	0.52
performing work with poor effectiveness	0.53	0.41
not complying with recommendations and binding procedures	0.64	0.37
conscious making mistakes	0.54	0.57
not reporting problems or acts of abuse at the workplace to superiors	0.61	0.33
destroying (completely) the property belonging to the employer	0.37	0.62
damaging (to a degree) the equipment	0.39	0.67
using up a greater amount of materials than necessary	0.73	0.39
intentional making the workplace dirty	0.60	0.52

Cont. table 6.

creating a negative image of the firm	0.66	0.41
intentional lateness for work	0.70	0.33
shortening the working time	0.81	0.14
prolonging breaks	0.87	0.13
leaving the workplace	0.77	0.20
intentional performing work more slowly	0.82	0.24
taking unscheduled days off work, e.g. due to having drunk alcohol	0.73	0.02
simulating sickness	0.82	0.19
surfing the Internet during working hours, the so-called virtual loafing	0.85	0.07
appropriation of employer's property	0.66	0.27

Source: own elaboration on the basis of conducted research.

An analysis of the content of the statements included in two factors (Table 6) allowed giving them the following names:

- Factor 1 – behaviors towards the organization.
- Factor 2 – behaviors aimed at colleagues.

In the case of the 2-factor model, physical aggression turned out not to be correlated either with Factor 1 or Factor 2. As regards some items (e.g. “conscious making mistakes”), factor loading distribution is even on both factors, not dominating strongly in one of the factors only.

## 4. Discussion

The dimensions of counterproductive work behaviors can vary in severity and impact on an organization, but collectively they pose significant challenges to maintaining a productive work environment. Identifying the dimensions of counterproductive work behaviors (CWBs) can yield both similarities and differences in the results, depending on various factors such as the context, the measurement methods used, and the specific behaviors considered. Across different studies and research, there tends to be a core set of CWBs that are consistently identified. It follows from the conducted research that the factor structure only partially corresponds to that given in the theoretical part. Thus, the five-factor model of counterproductive behaviors, proposed by Spector et al. was not wholly confirmed in the empirical research.

An important implication resulting from the own research is the observation that the items composing sabotage, abuses and worker's withdrawal are to a great extent identical with the items loading these factors in the original research (Spector et al.). On the other hand, in the case of certain items, the distribution of factor loading is uniform over several factors, not saturating strongly only one of them.

An important conclusion is certain departure from the recreated dimensions in comparison with the five-factor model of counterproductive behaviors proposed by Spector. Thus, there appears physical aggression as a factor which can be interpreted separately and which was perceived as a very negative behavior by nearly 100% of the respondents.

The results of confirmatory factor analysis of Baka et al. showed that a four-factor model comprising sabotage, abuse, theft and withdrawal – is characterized by the best parameters fitting the data presented by Spector et al. and this model was accepted by the authors. It needs adding that Baka et al. asked their respondents in the questionnaire straight about the frequency of the manifested counterproductive behaviors, simultaneously emphasizing that the respondents were not willing to admit to displaying unethical behaviors, even anonymously. It is understandable in view of the fact that certain behaviors in this category, e.g. physical aggression (beating, a consequence of which can be damage to health) or theft, are subject to legal regulations and it is a fear of being prosecuted eventually that makes the questioned not to admit to committing such acts. In Baka's et al. research, the majority of respondents marked the answers pointing to the lack of counterproductive behaviors at work, or a minimal intensity of such. Hence, the researchers suggest that a "more apt" method to examine CWB is asking respondents if they perceive a concrete behavior as negative or not, like in the question formulated as follows: "How negative, in your opinion, is the behavior of a worker who is doing his/her work slower on purpose?"

Bearing the above in mind, the authors of the present article asked the participants of the survey about their reception of individual types of counterproductive behaviors and on this basis carry out the measurement and taxonomy of CWB, which made it possible to accept a two-factor model, that is:

- Factor 1 – behaviors directed towards the organization.
- Factor 2 – behaviors directed towards coworkers.

The authors put forward the thesis that the model of counterproductive behaviors, which emerges as a result of own studies, will be based on fewer than five dimensions. The thesis has been confirmed.

Finally, it is worth drawing attention to the basic limitation of this research, which is changeability of organizational behaviors at the time of connecting them with, among others, social acceptance (or a lack of such acceptance) or encouragement (or a lack of encouragement) of counterproductive behaviors in the organization and – at the same time – the changing level of manifesting as well as perception of this type of acts.

## 5. Conclusions

While there are core dimensions of CWBs that are consistently recognized due to their disruptive and unethical nature, there can be variations in the results based on context, measurement methods, cultural factors, and the evolving nature of work. As the nature of work evolves with technological advancements and shifts in the labor market, new forms of CWBs, such as cyberloafing, have emerged. These behaviors might not have been as prevalent or well-documented in the past. It is important to consider these differences when addressing CWBs in a specific organizational or cultural context.

Research on CWBs provides insights that can inform the development of effective human resources policies and practices. Understanding the dimensions of CWBs can guide leadership and management in identifying early warning signs and taking action before these behaviors escalate. It helps managers become more effective in maintaining a healthy work environment. Knowing the dimensions of CWBs is essential for creating and maintaining a healthy and productive work environment. CWBs can have a severe negative impact on productivity. By identifying and addressing these behaviors, organizations can reduce disruptions, improve workflow, and ultimately enhance overall productivity. Research on CWBs enriches organizational behavior theories by providing a deeper understanding of the factors that lead to these behaviors.

The results of the own study encourage further discussion on physical aggression as a separately interpreted factor. Research findings that point to the significance of physical aggression can have practical implications. Policymakers and intervention programs might need to address this aspect separately in order to develop targeted strategies for prevention or mitigation.

In conclusion, research on the dimensions of counterproductive work behaviors is vital for fostering a productive, ethical, and supportive work environment. Additionally, it contributes to the development of academic knowledge and practical solutions for addressing these challenges in the modern workplace.

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## INNOVATIVE USE OF RESOURCES OF SPA TOURISM ENTERPRISES DURING THE HUMANITARIAN CRISIS CAUSED BY THE COVID-19 PANDEMIC

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**Purpose:** Study addresses the issue of an implementation, in a crisis situation, of an organisational innovation in the form of transformation of tourism and medical activities of Polish health tourism companies into crisis support centres for the health care system.

**Design/methodology/approach:** The COVID-19 pandemic was a difficult period for the tourism market, but by adopting the form of a natural experiment (Messer 2016) it allowed tourism enterprises to develop and implement new organisational solutions.

**Findings:** The research note shows the key conclusions from the research conducted in Polish health resorts in the period 2018-2021.

**Originality/value:** The article has practical value by showing solutions developed during the pandemic.

**Keywords:** health tourism, management, business model, Poland.

**Category of the paper:** Viewpoint (research note).

### 1. Introduction

Spa tourism enterprises are established to provide tourism and medical services in spa areas, i.e. locations with healthy climates. They pursue both tourism and medical objectives within the framework of the state's health care policy. During the pandemic period, the activities of spa companies took on a completely different role to the one they had previously fulfilled. While it was not possible for them to provide tourism and health services, their activities and infrastructure could be integrated with the state's system of emergency and preventive measures.

The purpose of this research note is to identify the innovative role of spa infrastructure in the health care system during the COVID-19 pandemic. The research note presents the most important results of empirical research conducted in Polish health resorts, and thus shows a new perspective on the use of health resorts in the public health system.

## **2. Short literature review**

The nature of this scientific work takes a limited form in the form of a research note, so only the most important points of reference are focused.

Previous research on the activities of spa businesses has focused on their economic, marketing, social policy, medical and historical problems (Ridderstaat et al., 2019, Gmyrek-Gołąb et al., 2022). The issues of sustainability (Hung Leea, Jan, 2019), business models responding to the challenges of climate change (Sigüenza et al., 2021) and applications of business models in the area of sustainability (Hossain, 2021) have been addressed only incidentally. An important piece of literature regarding the topic discussed is the study by K. Gmyrek-Gołąb et al. (2022) related to the operation of Polish health resorts during the Covid-19 pandemic. They present the offer of Polish spa companies in the field of rehabilitation of people after Covid-19.

The literature on the subject also formulates numerous recommendations and guidelines related to crisis management (Yu, 2006) and the implementation of critical changes in the functioning of organisations (Zenker, Kock, 2020). Some international organisations, such as the OECD, propose that tourism organisations take advantage of crisis situations and reorientate their policies towards more sustainable development (OECD, 2021).

However, a review of the literature revealed a lack of research relating to the business models adopted by spa tourism businesses during periods of global health crises, i.e. the transformation of their operations as a process of organisational innovation, triggered by humanitarian crises. This issue appears to be fundamental, given that, in periods of crisis, organisations need to adapt quickly to new conditions, and in such circumstances it is necessary to know how a company should change its business model while fulfilling its obligations in the area of corporate social responsibility. The identified research gap needed to be bridged by a separate study.

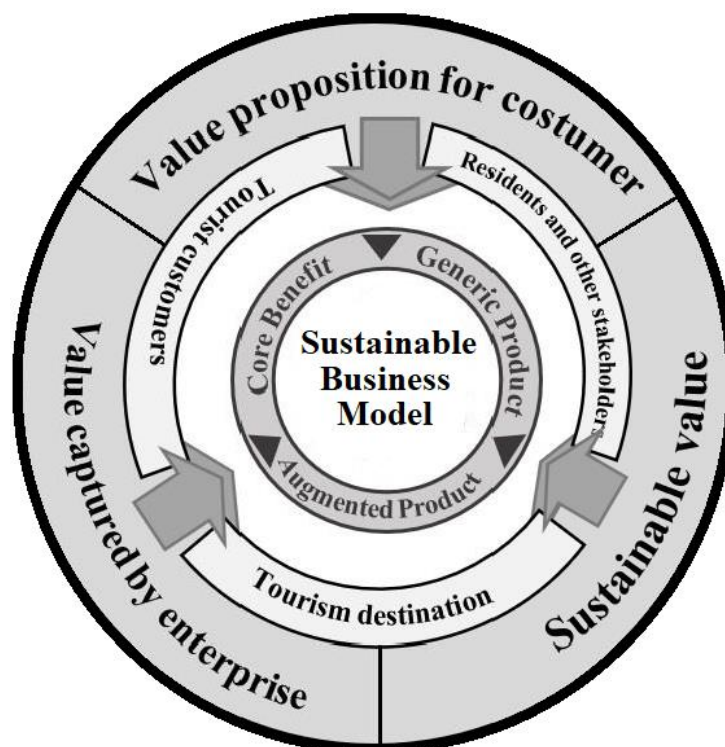
## **3. Conducting research and results**

The basic research problem was an attempt to identify the key transformational activities carried out by spa tourism enterprises and their positioning in crisis management models.

The research was conducted in Poland in two stages, in 2018 and 2021, following the methodology of the Generic Contingency Principle (GCP), referring to the assumptions of grounded theory. The research methodology included a triangulation of methods, i.e. in-depth qualitative interviews conducted among managers of the largest spa companies as well as among their current and potential customers. The research conducted in 2018 identified business models used in Polish health resorts, and the research conducted in 2021 aimed to identify the versions of these models to be used in crisis situations, taking into account elements of sustainable health tourism development (Figure 1). The opportunity for this was provided by the COVID-19 pandemic. In the analysis of business model components, the CANVAS diagram proposed by A. Osterwalder and Y. Pigneur (Osterwalder, Pigneur, 2010) was used. The quantitative research was carried out on a random sample of 753 respondents, of whom 63.5% (478 persons) were actual clients of Polish spas and 36.5% (275 persons) were qualified as potential clients.

Taking into account the current state of knowledge and the identified research gap, the following three research questions were formulated:

1. The application of what sustainability measures can be observed in spa businesses nowadays?
2. How is it possible to adapt the components of existing business models to use them subsequently in the development of sustainable business models?
3. What is the role of spa businesses in health crises caused by the risk of an epidemic?



**Figure 1.** The structure of a sustainable business model of a spa company.

Source: own study.

#### 4. Conducting research and results

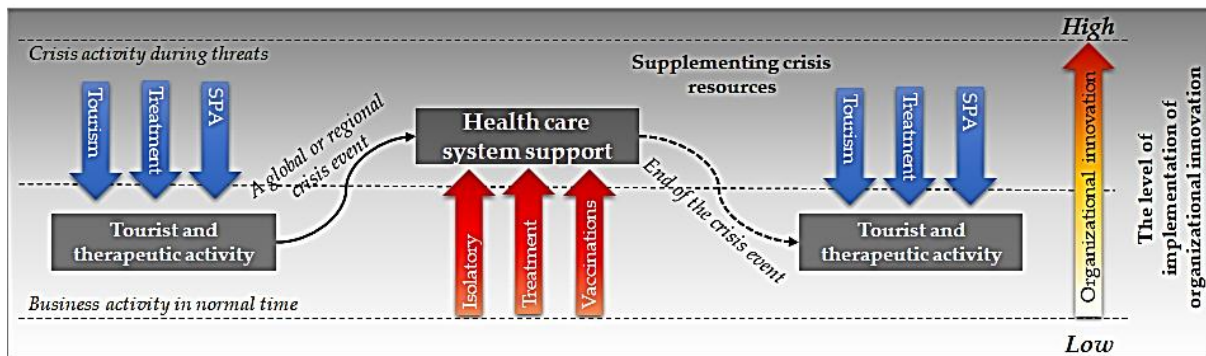
The research shows that the role of spa enterprises in situations of health crises caused by the threat of an epidemic is extremely important and takes diverse forms. It is noteworthy that in the first year of the pandemic, general spa therapies, i.e. standard tourism and medical services, were provided by 56% of the establishments, while post-COVID therapies, i.e. the treatment of patients who had suffered from COVID-19 and had a negative COVID test, were offered in 50% of them. 44% of the surveyed spa enterprises operated vaccination centres and 28% ran isolation facilities for COVID-19 patients. Only 11% of the spa companies and only during certain periods of 2020 provided exclusively tourism services.

28% of them purchased organic products as part of their tourism and medical services, and 72% reduced purchases, for example to avoid excessive stocks of food. Measures aimed at reducing the consumption of electricity and water were introduced by 56% of the businesses and 39% of them used renewable energy sources. All establishments had implemented at least one of the programmes aimed at reducing greenhouse gas emissions (6%), reducing demand for transport services (6%), reducing generation of pollutants, waste and harmful substances (89%) and segregating waste (94%). One in two spa businesses had implemented a sustainable development management system, but the vast majority of them did not communicate this to their clients.

The research showed that there were no barriers to the newly implemented management tool adopting the form of a sustainable business model, including an extended value proposition. Taking into account that it is more efficient to introduce successive versions of a particular model in an evolutionary way, it was proposed to introduce a standard model that could be gradually developed into a sustainable model containing not only business objectives and strategic directions, but also various ways of achieving the sustainable development goals proposed by the UN, as well as ways of generating value propositions based on juxtaposing a value map with the needs of the environment and stakeholders.

Subsequently, the research proposed a transformation of a sustainable business model into a model taking into account not only a sustainable value proposition, but also an important extension of the scope of activities in circumstances of humanitarian crises. A so-called critical business profile was proposed as a component of a model to be triggered in situations of threats to ordinary business operations, as was the case during the COVID-19 pandemic.

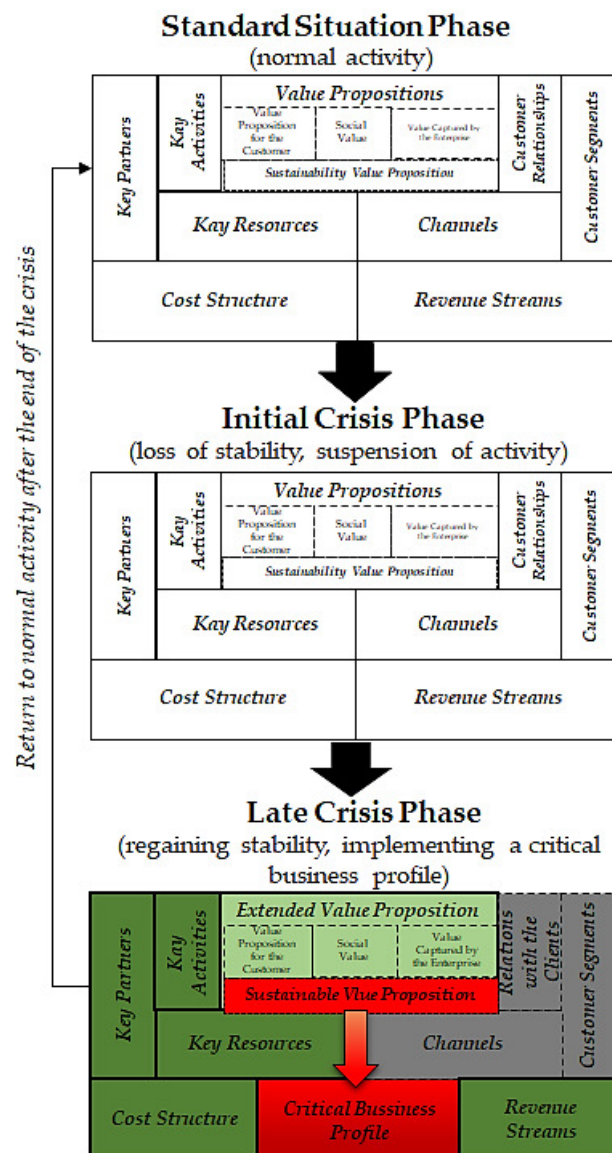
This component should include basic plans to change the business profile from tourism and medical services to broadly understood rescue activities. As proposed, these should include: contingency plans aimed at reducing the local impact of health, environmental and military disasters, scenarios for rapid business turnaround in a coordinated emergency response, as well as infrastructural (evacuation and medical) and material reserves. Figures 2 show a change in a business profile and a business model transformation during the COVID-19 pandemic.



**Figure 2.** Changes in the profile of the business model.

Source: own study.

In turn, Figure 3 shows the transformation of business models in individual phases of a humanitarian emergency. It takes into account the components of business models and their mutual relationship, as well as a direct reference to sustainable business models.



**Figure 3.** Three phases of changes in the form of business models.

Source: own study.

## 5. Conclusion

Crisis situations are an opportunity for learning and rapid changes of business models that must take into consideration not only sustainability development objectives, but also ways of managing crisis situations, including a quick change of a business profile and scope. The prospect of further research indicates the need to take into account the individual conditions of spa enterprises in business models.

The research results presented in this research note show that modern health resorts and their infrastructure can be used much more widely than before. It is extremely valuable to develop new practices of involving medical and tourist personnel employed in sanatoriums and rehabilitation centers in health resorts, to achieve the goals of saving the lives and health of the local population in situations of humanitarian threats. The research note presents an example of such rescue activities undertaken by health resort companies in Poland during the COVID-19 pandemic. The hope of the authors is to promote such activities and to consolidate them in the business models of spa enterprises.

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## THE IMPACT OF TECHNOLOGICAL DEVELOPMENT ON CHANGES FOR CORPORATE MANAGEMENT

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**Purpose:** Nowadays, technology and knowledge management are becoming key components in business management methods. The paper aims to indicate different ways of approaching technology management, taking into account factors shaping the market and determining barriers to making long-term decisions but also the ongoing digital transformation.

**Methodology/Approach:** The paper is a general review of technology management methods in enterprises and is based on the analysis of available domestic and foreign source literature, a synthesis of studies and reports of selected organizations dealing with the analyzed issues, as well as the authors' previous theoretical research.

**Findings:** The research results indicate an increase in the importance of knowledge and technology management, which result from the pace of technological change and the ongoing digital transformation in many areas that directly affect the functioning of an enterprise in the modern world.

**Practical implications:** The paper indicates methods of knowledge and technology management based on the challenges of modern enterprises related to digital transformation and resulting from the turbulent changes in the market of new technologies. Based on the conducted experience, the authors diagnosed key factors and elements related to methods of acquiring technology to achieve competitive advantage and improve economic efficiency.

**Originality:** The article expands knowledge about the impact of technology development on enterprise management methods, as well as points to current challenges arising from the issue of knowledge management, taking into account the need for selected enterprises to make long-term financial decisions. To illustrate the problem, the authors used the example of mergers and acquisitions.

**Keywords:** knowledge management, merger and acquisitions, corporate finance, technology, digital transformation.

## 1. Introduction

Technology supports the functioning of the company in various areas of its activity. The term “technology” has been evolving for many years along with technological progress, which is noticeable in many areas including economics. Derived from Greek, the term “technology” is a combination of words “techne” – art, crafts and “logos” – science, reason (Pellegrino de Souza et al., 2015, p. 94). From the economic and organizational point of view, technology is associated with a process that is strictly sequential, which means that it produces a finished product with specific functional characteristics from the initial goods (materials, semi-finished products or raw materials). The development of technological systems, mainly ICT, in enterprises dates back to the second half of the 20th century, in particular from the 1980s, and in Poland from around 2000. The process is called “management of technology”, which, according to the National Research Council (NRC) in the United States, includes criteria related to: identification and assessment of technological possibilities, management of research and development works and determining the degree of feasibility of a given project, integration available technology, implementation of new technologies in processes and products but also issues related to obsolescence and technology replacement (NRC, 1987).

In the context of enterprise management, it is crucial that technology contributes to increasing (maximizing) the efficiency of resource use. It focuses, among other things, on reducing costs and, consequently, increasing potential operating revenues. Access to highly effective technologies, i.e. those that enable the highest possible number of products to be obtained from a small amount of inputs. Technology is subject to frequent changes that aim to improve management processes, creating new opportunities and thus strengthening the company's competitive position on the market.

The research was conducted based on a source literature review, available scientific examinations in the field of management and corporate finance and an analysis of reports and statements related to the issues of digital transformation and technology management. The paper aims is to analyze the factors determining the development of modern enterprises under the influence of technological changes and to present the economic effects resulting from them.

Therefore, the authors pose the following research questions:

- 1) Does technology influence globalization processes, including merger transactions?
- 2) What role do technological processes play in the context of management methods in modern knowledge-oriented enterprises?
- 3) What factors determine the success of implementing modern technologies according to current management concepts?
- 4) What barriers do enterprises encounter due to technological changes and what challenges do they face?

## 2. Corporate management in the context of technological changes

The development of modern enterprises depends on the adopted strategy and business model, which is often based on technological support. From the point of view of corporate management, as well as the organization of internal processes, the factors that are important are those that actually optimize communication between various groups of recipients located internally (ranking employees, management staff, owners) and externally (suppliers, customers, competitors, investors). enterprises. This is done through continuous exchange of information at various management levels but also in relations with other enterprises, public institutions and private investors. The increasing unpredictability of economic changes forces managers to make various decisions, often in a situation of incomplete information and the inability to forecast the future (Firlej, Bargieł, 2014). One of them are globalization processes, which, on the one hand, lead to the unification of markets and the creation of competition on a global scale (existence of large enterprises), but, consequently, on the other hand, the need to adapt to the conditions of the international economic environment (external perspective) and ways of organizing work and managing an enterprise. (internal perspective). The main technological factors influencing management include: automation and computerization, development of telecommunications and computer support systems, development of transport and road infrastructure but also everyday technologies, soft ecological technologies and the use of alternative energy sources, which reduce the consumption of fossil fuels and increase energy efficiency (Toborek-Mazur, Partacz, Surówka, 2023). The above diagnosis is the answer to the first research question.

The development of technology and, consequently, media (traditional and social) has accelerated many processes on the market, including: globalization. M. Łuczak notes that the more developed the technology, the greater the pace of change (Łuczak, 2017). Modern technology, especially in combination with wireless Internet connectivity solutions, leads to many changes in the functioning of enterprises. For example, when analyzing enterprises in the tourism sector, several directions are distinguished, including:

- ability to implement market innovations, in particular in terms of estimating and predicting future costs and access to new markets,
- increasing access to the tourism market by increasing tourist offers and announcements published on the Internet by travel agencies,
- improving internal business processes of enterprises related to the flow of information through electronic communication channels,
- changes in the balance of power between service providers and recipients related to increased general availability of information on new and existing markets,

- increasing cooperation between tour operators and other service providers, resulting in an increase in the diversity of holiday offers and service negotiations,
- higher level of interoperability with both internal and external participants of the business process (Kurlito, 2013).

All these activities lead to an increase in the importance of competitiveness on the markets in which the company operates, both on a national and international scale. They also influence the increase in demand for information management as a measure of the effectiveness of managing internal processes in the collection, processing and interpretation of data that represent value for the company. Objective measurement of value management is made on the basis of the so-called market value added (MVA) but also economic value added (EVA). Their use in many enterprises involves estimating a strategy that maximizes the value created. This is the case, for example, in companies interested in a merger or acquisition transaction, in which the accuracy of measurement of the possible profits and expected costs of the merger, relative to the expected value, by all participating parties, plays a key role. Therefore, in this case, one of the key factors is synergy, which is created as additional value after the merger. Economic and organizational success depends on the effectiveness of transaction management processes, from the pre-transaction phase, through signing the contract, to the integration phase. An important role here is played by access to information but also by means of optimizing decision-making processes, which are most often based on the use of modern technologies. Analyzing the subject literature, it can be concluded that the most important IT systems implemented in enterprises include (Misztal, Fajczak-Kowalska, 2020):

- Customer Relationship Management,
- Partner Relationship Management,
- Manufacturing Resource Planning,
- Enterprise Resource Planning,
- Supply Chain Management,
- Business Intelligence,
- Workflow Management,
- Knowledge Management.

The multitude of different mechanisms optimizing the decision-making process in the enterprise is important from the perspective of logistics enterprises that use IT systems to carry out multi-level resource planning. This fact results from the implementation of various management support systems, which are most often observed in enterprises from the TSL sector, i.e. transport, forwarding and logistics. In practice, it depends on the exact specificity of the business activity, but in the literature it stands out, among others: benchmarking (based on comparing, measuring, searching for and confronting various solutions compared to the solutions proposed by the so-called best in a given field, industry or group), comprehensive quality management (oriented at increasing the level of competitiveness and profitability of the

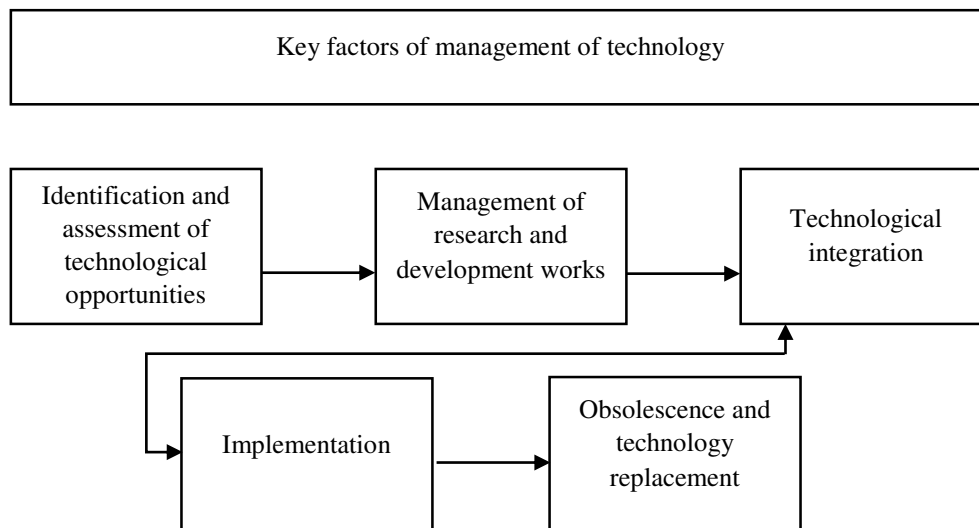
company), lean management (oriented to reduce costs, increase quality and shorten the delivery cycle), Six Sigma (a statistical tool for improving processes by increasing profitability and subordinating management to eliminate defects), outsourcing (separating some specialized tasks from one's own organizational structure to another entity) or Business Process Reengineering (through rapid redesign of processes in the enterprise resulting in cost reduction, increased efficiency and shortening the duration of processes towards the implementation of team work).

### **3. Factors determining the success of implementing modern technologies in an enterprise according to the concept of technology management**

Enterprises have different areas of technical knowledge that enable them to achieve specific goals. It consists of an appropriate technological base, which is knowledge codified in the form of appropriate procedures, sketches, instructions or diagrams but also tacit knowledge possessed by employees and teams of employees, as well as machines and devices used in the production process. Technology in the production process is often protected by intellectual property rights in the form of patents, licenses or know-how, which together create intangible technological assets that generate additional value for the company. As technology is the basis of competitiveness and often a source of innovation within the enterprise, such value is treated as the basic source for estimating the value of the entire enterprise (Urbanek, 2011, p. 49). Therefore, it is important from the perspective of investments made by existing or potential investors.

According to M. Dolińska, enterprises focused on innovative solutions should be characterized by the ability to introduce new goods and services to the market that will allow them to achieve high revenues, while at the same time trying to further develop so that the implemented solutions do not start to lag behind the competition (Dolińska, 2010, p. 27).

According to I. Hejduk and W. Grudzewski, technology management involves managing technological changes (Hejduk, Grudzewski, 2008). However, according to K. Klincewicz, it is an interdisciplinary process that combines various functions in the company based on knowledge in the field of strategy, marketing, finance, production and research and development (Klincewicz, 2010). According to A. Becla, information technology management mainly includes creating, ensuring the efficiency of operation, modernizing and securing appropriate information and IT infrastructure in the form of hardware and software, as well as the use of organizational structures and human resources for the efficient functioning of this infrastructure (Becla, 2019, p. 37). Figure 1 indicates the most important criteria related to technology management.



**Figure 1.** Key factors of management of technology.

Source: author's own studies based on (NRC, 1987).

Based on the above diagram, it can be seen that the order in which key technology management factors are disclosed follows a logical structure. Firstly, there is a need for a given company to identify and assess technological possibilities. The role of knowledge management combined with the use of information technology tools is revealed here. Although, as M. Plebańska points out, the very definition of a "technological tool" in the context of knowledge management is difficult to clearly classify due to different degrees of functionality. Nevertheless, the mechanisms supporting the knowledge management process include three basic technological systems, i.e. database technology (based on database mechanisms and programming language systems), network technology (related to the exchange of data at the hardware level using dedicated servers and software intended to perform these activities) and web (combining database and web technology, including on dedicated websites) (Plebańska, 2016).

It is worth emphasizing that between the individual knowledge management criteria and the decision-making and financial capabilities of the enterprise, technology plays a specific information role. This is the basic role of technology, because in an enterprise it is based on information processing. Answering the next research question, the authors state that in the context of knowledge-oriented management methods, technology enables the identification, collection and selection of data that generates enterprise value. However, the essence of knowledge lies in the method of its use, and not in the process of collecting information resources (Szaban, 2003, p. 44). Therefore, if we adopt a pyramidal structure (the so-called knowledge pyramid), in which the narrowest quantitative scope is knowledge, then information, and the broadest is data, then knowledge is the substrate of information and data used to take a specific action. If a given person has knowledge, he or she also has appropriate data and information that enable it to be used (to make decisions). In an enterprise, they mainly serve to assess various economic solutions (financial, management, organizational) (Kłusek-Wojciszke, Łosiewicz, 2009, p. 137).



However, only explicit knowledge (that can be saved on a medium) can be subjected to technology. This means that tacit knowledge cannot be easily captured and used, because its source is all information that is not schematic and formalized, e.g. individual skills or qualifications of an employee, which are also important from the perspective of the company's value. This is especially noticeable in mergers and acquisitions. Synergy, as the basic determinant for making these decisions, is not clearly identifiable numerically, because its size is influenced, apart from financial factors, by non-financial factors such as brand or reputation, and these are not directly identifiable (Toborek-Mazur, Partacz, 2022a). However, it is important from the perspective of enterprise valuation and it is often the subject of negotiations in the merger. Because of it, it is possible to create databases in which they are stored and processed, and then made available to various end users. As knowledge management uses information technology mechanisms, the degree of their usefulness depends on the behavior of a person (information user) – his or her skills, experience, ability to interpret facts and data.

For example, the ability to estimate investment risk allows for investments whose risk level will be as low as possible for the investor. Based on the information from the financial statements, the investor is able to make a decision about the transaction, postpone it or abandon it. From the perspective of corporate finance, it is additionally important to adopt technological solutions that will not significantly reduce the company's financial capacity in the long term and, at the same time, will contribute to reducing costs.

#### **4. Models for creating technological potential**

There are several models for creating technological potential. Some are focused on solutions coming from outside, i.e. from other enterprises on the market, universities, government or commercial research institutes and laboratory centers, and others are focused on developing their own research and development base. The basic advantage of scientific and technical solutions obtained from outside the company is that it is the shortest and most profitable, and at the same time characterized by relatively low risk, way to strengthen its own technological potential. In this sense, technology appears as a strategic resource, and technology transfer as one of the ways of development determining the market success of an enterprise (Glabiszewski, 2016).

The thesis is confirmed by R. Tylżanowski, who points out that technology transfer is an essential determinant of economic success. It is based on providing a set of information that ensures proper conduct of business activities, e.g. methods and methods of production (Tylżanowski, 2016). It is therefore a process of transferring tangible and intangible resources between specific entities for their absorption by the final buyer, both in the original and

transformed form. Such activities highlight the importance of technology companies conducting mergers and acquisitions. Mergers and acquisitions are transactions aimed at acquiring appropriate company assets, either in the form of a merger or acquisition. In the case of a merger, a new entity is created from two existing ones. However, the acquisition may be based on the purchase of licenses, patents, utility models, know-how, machines or technical devices. Therefore, the subject of takeover may be the entire enterprise, its separated part, or even individual assets. This is often associated with the flow of intellectual capital (individual skills, technological consulting), which is an important link in the process of implementing modern technological solutions. The growing interest in mergers and acquisitions among technology enterprises in Poland is confirmed by data collected by Fordata and Navigator Capital. The most active sector in M&A in 2018-2022 in Poland was the technology, media and telecommunications sector. The variability of individual data results from differences in the number of transactions carried out, also determined by the buying and selling parties within the transaction. Data on mergers and acquisitions in technology companies by sector are presented in Table 1.

**Table 1.**

*Mergers and acquisitions in technology companies (sectoral approach)*

Year	Most active sector (acquired entity)	Buyer	Seller (private investor)
2018	18%	14%	56%
2019	18%	20%	56%
2020	22%	19%	57%
2021	26%	22%	62%
2022	23%	19%	67%

Source: author's own studies based on Fordata and Navigator Capital 2018-2022.

Analysis of table 1 shows that the most active sector in Poland in terms of mergers and acquisitions was the technology, media and telecommunications sector. The highest percentage in the years examined was recorded in 2021 - 26%, and the lowest in 2018-2019 - 18%. This sector also participated to the highest extent in mergers and acquisitions transactions as a purchasing party. The range of sector involvement in the analyzed years was between 14% in 2018 and 22% in 2021. The selling side in all analyzed years were private investors, whose percentage of involvement in transactions fluctuated from 56% in 2018-2019 to 62% in 2021.

In the organization of an enterprise, it is important to manage one's own research and development works, in which it is possible to limit ineffective processes. In this context, difficulties arise in obtaining tacit knowledge, as it requires individualized employee involvement in terms of experience, competences and skills. In the literature stands out the SECI model of knowledge dimensions, which involves the conversion of tacit knowledge into explicit knowledge (Syed, Murray, Hislop, Mouzugh, 2018, p. 80). It is based on knowledge transfer within the organization and consists of 4 steps:

- socialization (transfer of knowledge between employees),
- externalization (externalizing hidden knowledge and transforming it into standardized knowledge for all employees),
- combination (served to create more complex concepts based on already cataloged formal information),
- internalization (consisting in processing explicit knowledge in such a way that it is used constantly in the individual's everyday work).

In fact, the aim of the model is to create new knowledge in the organization by encouraging employees to develop and deepen specialized competences, which improves the level of innovation, in particular in relation to research and development work. The use of tacit knowledge may therefore contribute to the increase in intellectual capital and, therefore, the increase in the competitiveness of the company on the market, which may also affect the company's valuation. For the organizational structure of the enterprise and taking into account its financial management, it will be important that the use of the increase in intellectual capital resulting from the conversion of knowledge may contribute to the optimization of workload and, therefore, the reduction of financial costs allocated to the implementation of a specific task (reducing the number of corrections and errors). , which may consequently lead to faster implementation of the entire research and development project (Śliwa, 2016). Thanks to the use of knowledge and technology, the company determines a set of various financial instruments, e.g. accounting programs, budgeting models and goods and sales management, that are adequate to the profile of its business. In production companies, this is done through appropriate warehouse management based on the coordination of demand and supply. As it is important for enterprises to reduce waste, any storage of too large or insufficient number of goods in relation to the needs leads to financial losses (Świętoń, 2020). The use of knowledge management and warehouse management in such an enterprise will therefore be aimed at developing technologies and logistics for the transport of goods that will optimize the frequency of deliveries and delivered goods, e.g. within one transport.

Another element of technology management is technological integration, which is based on the combination of available solutions with the needs of relevant departments and units of the enterprise (Partacz, 2022). Taking into account complex structures, e.g. within group of companies, it also requires coordination with various entities, in particular with the extensive and diverse business profile of the group of companies. The next step is to implement technological solutions and monitor the degree of task feasibility with the support of the implemented technology. Well-implemented technological solutions enable the achievement of operational and strategic goals through a combination of various legal, economic, financial and organizational aspects that improve the planning and commercialization process and contribute to achieving the expected level of innovation. In the last step, the wear and tear of the technology is assessed and a possible decision to replace it is made. Technology, like knowledge, gradually becomes outdated and trivialized over time, which causes its value

to decline. Thus, it can be stated that enterprises cannot stop at using one technology, but constantly monitor its economic usefulness and, if necessary, replace it with another one.

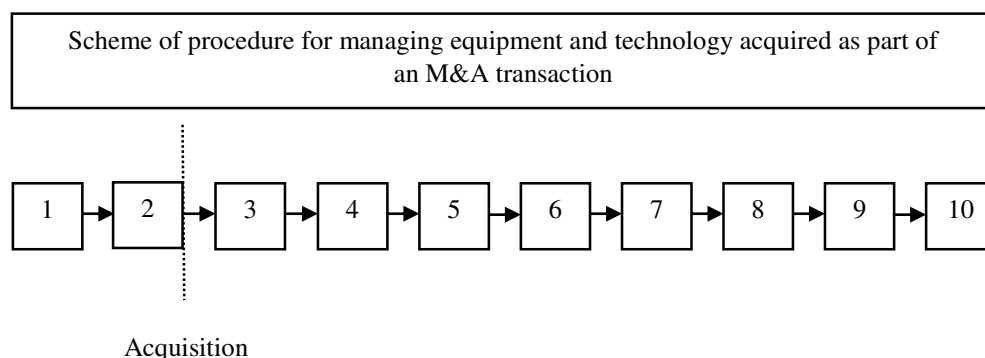
The idea of technology management is based on the combination of many different aspects of technology - science, technology, processes improving management and results from the continuity of technical changes in the world. Apart from the purely theoretical static scope, it is also understood in a dynamic way, i.e. focused on efficiency adapted to the current and potentially future achievable results of the process. It follows that the development of technology is the basis for the development of an enterprise, as it is a substrate for creating competitive leverage but also a method of limiting ineffective processes that generate costs and reduce the investment opportunities of entities. It applies to those enterprises that have too much management organization, which creates too many communication channels that hinder the rapid flow of information and, therefore, decision-making. That's what happens, when during the integration phase in merger and acquisition it is necessary to remove duplicate departments or positions that do not bring tangible benefits (Toborek-Mazur, Partacz, 2022b). Therefore, one of the most important elements of technological management should be marketing activities focused on economic analysis of the profitability of future activities, ensuring economic and technological security. This applies especially to large international enterprises that use technologies developed by external entities or that directly delegate some tasks (outsourcing) to other entities. This requires the company to adapt to the cultures and organizational and legal orders prevailing in the given country where these tasks are performed or from which the technology is obtained but also to cooperate with other companies located in a given regional market. The indicated factors determine the implementation of modern technologies and thus provide the answer to question 3.

The model of key technology management factors can be expanded with observations, among others: D. Cetindamar, R. Phall and D. Probert. They noticed that technology management should be adapted primarily to the following criteria, i.e. identification, exploitation, selection, acquisition, protection and acquisition of knowledge in order to achieve and maintain a high market position (Halicka, 2014). One of the advantages of the technological management model is the possibility of applying it to any enterprise, regardless of its size (Cetindamar, Phaal, Probert, 2004). However, the use of technology management should be distinguished from the technology itself.

One of the basic challenges in the company is the problem of the so-called assimilation gap. It appears when an enterprise, despite implementing technological solutions, does not use it because the main obstacle is the inability to operate it, e.g. software. This fact results from the insufficient level of knowledge and skills to use it. An additional management problem is the phenomenon of information overload, which manifests itself in those entities that, due to too extensive organizational structure, have a small base of people making binding decisions. Then there is a problem related to the selection of data that are important from the point of view of a specific problem, leaving out some of them that, although not binding, may strengthen or

refute the validity of the decision being made. At the same time, as K. Klincewicz points out, companies are concerned about the risk of reducing work efficiency related to the possibility of replacing some repetitive tasks performed by employees with automated technological systems or algorithms (Klincewicz, 2016).

To illustrate the technology management process, the authors propose the analysis of the following example. The example illustrates an attempt to modernize the efficiency of the manufacturing department “Y” in company “X” by acquiring assets as part of a merger and acquisition transaction. The technology used contributed to improving the quality of manufactured “W” products by improving the quality of repeatable “C” activities in the process of processing this product. Improving quality included replacing selected manual activities in the production process with automated “S” equipment. The use of the new technology resulted from the transaction undertaken by company “X” to take over company “Z”, which among its assets had equipment “S” for performing automated activities that facilitate the production of product “W” in less time than manual work. Company “X” expects the emergence of further production opportunities thanks to the takeover of company “Z” by expanding its product offer. The course of the technology management process as part of corporate management is presented in figure 2.



**Figure 2.** Management of acquired company’s technology as part of mergers and acquisitions.

Source: author’s own studies.

The procedure consists of 10 steps. In the first step, company “X” identified opportunities to improve its own production process by modernizing the functioning of the production department “Y”. It was diagnosed that some of the tasks performed in the production process could be replaced by automated equipment to produce the “W” product. Assumptions for the implementation and operation of new equipment regarding the efficiency, time and quality of the process were prepared and developed. The company also estimated the potential financial benefits and threats resulting from the purchase of equipment, analyzing various options for purchasing technology on the market - cash purchase of a ready-made machine, leasing or taking over another entity. In the analyzed case, the company was taken over, although it was the most expensive option. Nevertheless, due to the unique technical parameters, own financial capabilities, long-term development perspective and acquisition opportunity, the owners

decided to take over. In the next (2) step, the entity “Z” was taken over along with its assets, including the “S” equipment. In step (3), company “X” started rebuilding the entire production system and production hall, adapting it to the implemented equipment. This involved equipping the workstation with additional tools for assembling and starting the machine. Subsequently, the machine was adapted to individual processing parameters in order to produce the components of the “W” product - the software controlling the equipment was updated along with the definition of additional parameters resulting from production needs. Step (4) was based on the development of technical documentation for monitoring and maintenance of the equipment by a qualified team from outside the merged companies. In step (5), the implemented technology for automatically performing activities “C” using the acquired equipment was tested.

During testing, it was noticed that adding an additional element “E” and changing the parameters will reduce the time of performing activity “C” by approximately 15%. Therefore, the software controlling the “S” hardware was updated again. Testing was based on the performance of activities, in such a way that the first test included activities performed in a simplified way (only a few selected ones, with the support and supervision of employee “P”), so that subsequent tasks were more advanced and included a lower degree of support and supervision of the employee “P”. The tests used various materials and equipment components necessary to produce “W”. After successfully testing the functioning of the equipment and obtaining satisfactory processing results by the machine, the technical documentation was completed in step (6) by correcting selected parameters and activities. In step (7), specialized training was carried out for employees who will be responsible for operating the “S” equipment - both through manual operation of the station and in the use of the control software. In steps (8) and (9), the effectiveness was verified, respectively, by the employee operating the equipment and by the employees of the department responsible for assessing the implemented solutions. Step (10) includes completing the verification of the usefulness and profitability of taking over enterprise “Z” and equipment “S” in the form of preparing a report.

## **5. Challenges related to business management resulting from technological changes**

One of the basic features of the functioning of enterprises on the market is the turbulent nature of changes, which generates the need to adapt the structure of the organization in such a way that it effectively prevents various unfavorable events through anticipation. Nowadays, management is based on multidirectional processes, subsystems and projects often implemented in multidisciplinary teams. The flexibility of the organizational system is based on the ability to generate and make changes based on emerging new situations in which it is

necessary to use a specific action strategy (Dźwigoł, 2014). The more flexible the system, the better the adaptability. As K. Koziół points out, the turbulent nature of the competitive environment is manifested, among others, by its complexity, i.e. a high number of elements and connections but also the speed of changes resulting from technological or organizational innovations, intensity - generating an increasing degree of dependence of the company on its environment, difficulty in prediction of future events and the determinants causing them and the resulting high level of risk (Koziół, 2010).

The number of business relationships concluded between enterprises is constantly increasing, not only directly but also using technological solutions and a network organizational structure. The uncertainty of the economic environment, as well as the inability to choose specific methods and information barriers make it necessary to adapt a specific management model to the competitive conditions prevailing on the market (Szymańska, 2012). Assessment of the economic condition of an entity, taking into account financial and non-financial criteria, requires comparison to the results of competitors, which can often constitute a role model in particular areas. Enterprises use diagnostic analyzes to identify the company's strengths and weaknesses that are made in areas such as sales, production and finance but also in marketing, logistics and resources management (Toborek-Mazur, 2022).

Barriers to the functioning of an enterprise can be divided into internal and external. Internal barriers include primarily the weaknesses of the enterprise itself, and concern the issues of size, organizational structure, operating strategy, own production capabilities, financial, material and intangible resources but also skills and competences. External barriers include primarily threats arising from the company's environment. As a result of general economic fluctuations but also because of functioning in a specific market or industry (Ziemba, Świeszczak, 2013).

Table 2 contains a set of the most important challenges facing contemporary organizations, ranked according to three basic criteria, i.e. social and marketing, technological, and international and market. It is also the answer to question 4.

**Table 2.**

*Selected challenges of modern enterprises related to technology*

Social and marketing	<ul style="list-style-type: none"> <li>- corporate social responsibility as a basic criterion;</li> <li>- making long-term decisions based on social and economic criteria;</li> <li>- uniting employees around the goals and values set by the company;</li> <li>- striving for balance in the development of employees and the enterprise;</li> <li>- ensuring favorable forms of employment and working conditions;</li> <li>- taking care of a favorable external image;</li> <li>- implementation of solutions consistent with moral principles according to the compliance and corporate governance system;</li> <li>- taking care of favorable relationships with the competitive environment but also with contractors, customers, suppliers and business partners.</li> </ul>
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Cont. table 2.

Technological	<ul style="list-style-type: none"> <li>- the pace of information transfer and processing;</li> <li>- development of information and communication technologies;</li> <li>- dynamics and unpredictability of technology development, which force the need for continuous improvement and learning;</li> <li>- virtual simulations and real-time data processing;</li> <li>- variability of production technologies and the speed of technology obsolescence;</li> <li>- complexity of IT architecture and cyberphysical systems;</li> <li>- viewing technology as one of the tools supporting the decision-making and knowledge management process.</li> </ul>
International and market	<ul style="list-style-type: none"> <li>- internationalization of the management system,</li> <li>- the need to adapt to different organizational cultures and legal orders,</li> <li>- employing staff from different geographical areas,</li> <li>- results orientation;</li> <li>- interdisciplinarity of knowledge;</li> <li>- decentralization of technology depending on the place of its use and access to resources and raw materials used in the production proces.</li> </ul>

Source: author's own studies based on (Marzec, 2020).

Analyzing table 2, it can be seen that there are a number of factors determining the development of enterprises on the market. Undoubtedly, the ability of organizations to adapt and anticipate helps improve the overall level of management, reducing the risk of failure resulting in unforeseen financial costs. It is noticeable not only on the new technologies market but also on the financial (84% of responses) and energy (72% of responses) markets, which are susceptible to technological changes and innovations. According to a study conducted by EY, three technologies have the greatest impact on the development of the financial industry, i.e. artificial intelligence (90% of responses), automation and robotization (54%) and cloud computing (46% of responses). The greatest barriers related to the dissemination of technology in the financial sector include high costs and lack of a sufficient level of capital (70% of responses), cybersecurity (49% of responses) and legal barriers (40% of responses). Similar indications can be seen when taking into account the results of the energy industry. The real estate industry (63% of responses) and the production and service industry (60% of responses) are the least susceptible to technological innovations (Bogusławski, 2020). The research shows that sectors that are susceptible to the dynamics associated with technology development require the implementation of additional solutions that protect not only the internal interests of the company. They must pay attention to adapting to functioning in a competitive market. The progress in the development of digital technologies has been intensified, especially in recent years, due to the coronavirus pandemic, which forced the reorganization of many enterprises, replacing some of the tasks performed stationary, i.e. at the workplace, with remote work. According to a report by the Humanites Institute, 93% of managers and 88% of employees among the surveyed enterprises declared that the pandemic accelerated digital transformation. At the same time, as many as 78% of organizations from the medium and large enterprise sector are undergoing digital transformation, and 36% of them are at an advanced stage. 92% of managers see cost optimization as the basic premise and benefit justifying investment in the development of digitalization, and 80% point out the high costs of this transformation in its initial stages. 63% of respondents believe that new



technologies negatively affect people's mental and physical health. Compared to the competition, respondents note a similar level of advancement of digital transformation - 65% on the Polish market, 44-54% on the foreign market (Humanites, 2021). Table 3 lists the reasons for digital transformation in enterprises, ranked by importance: very important, important, unimportant.

**Table 3.**

*Reasons for carrying out digital transformation in companies*

Factor	Very important	Important	Unimportant
Increasing process efficiency	49%	50%	1%
Increasing sales/revenue	45%	48%	7%
Cost optimization	39%	60%	1%
Responding to changes	34%	64%	2%
Keeping up with the market	29%	68%	3%
Improving the services/products offered by the company	29%	67%	4%
Increasing safety among employees	17%	68%	15%
Staff development	9%	83%	8%

Source: author's own studies based on (Humanites, 2021).

The analysis of Table 3 indicates that the most important criteria for implementing digital transformation include increasing the efficiency of processes, sales and revenues. At the same time, the development of employees and increasing their safety, as well as keeping up with market trends, are considered important. These factors mainly result from digital transformation and changes in the modern world. Recognizing the internal and external barriers of the company allows you to prepare in advance for changes in the future. According to research by the Infuture Institute, 82% of respondents believed that technological factors have a very large impact on the digital transformation process. In the coming years, according to the authors, the importance of technological factors such as automation, Big Data, AI, Internet of Things, blockchain, brain machine interface, speech recognition, bioplastics and quantum computing will increase in Poland (Infuture, 2019).

## 6. Summary

To summarize the considerations, it should be emphasized that the success of enterprise in the modern world depends on many criteria that are not always predictable, especially in markets that are susceptible to frequent changes. Important technological factors that influence management are primarily automation and computerization, the development of telecommunications and computer support systems, road infrastructure, but also everyday life technologies and soft ecological technologies. The ongoing process of globalization and with it frequent and rapid changes on the market require long-term changes in the area of business management. It promotes the exchange of information and the dissemination of modern technologies, accelerates the transfer of development factors and disseminates knowledge,

but at the same time it means the economic expansion of international enterprises, combining the organizational cultures of transnational corporations. Additionally, it makes supervision more difficult by using various solutions in the field of internal work organization systems. Various decision criteria depend on taking into account the uncertainty factor and the need for information. This is especially noticeable in those companies that rely on technology and base the knowledge management process on technological factors, adapting it to current challenges and threats on the market. Technology enables the identification, collection and selection of data that generates value for the enterprise itself. In each case, knowledge is important as it constitutes the basis for information and data used to take a specific action. If a person has knowledge, he also has appropriate data and information that allows him to make decisions also regarding connections. Only explicit knowledge can be subjected to technology. Tacit knowledge cannot be easily captured and used, because its source is all information that is not schematic and formalized, e.g. individual skills or qualifications of an employee, which are also important from the perspective of the company's value. This is especially noticeable in mergers and acquisitions. However, both are important from the perspective of enterprise valuation and are often the subject of negotiations during the merger process. Technology transfer is an important determinant of economic success. It is based on providing a set of information that ensures proper conduct of business activities, including the selection of appropriate production methods. It is the process of transferring tangible and intangible resources between specific entities in order to be absorbed by the final buyer, both in the original and transformed form. Such activities are visible in the processes carried out by technology companies regarding connections.

Such processes are often associated with the flow of intellectual capital (individual skills, technological consulting), which is an important link in the process of implementing modern technological solutions. The authors confirmed the increased interest in mergers and acquisitions in technology enterprises in Poland. The most active sector in M&A in 2018-2022 was the technology, media and telecommunications sector. The number of business relationships concluded between enterprises is increasing, not only directly, but also using technological solutions and a network organizational structure. The uncertainty of the economic environment, as well as the inability to choose specific methods and information barriers make it necessary to adapt a specific management model to the competitive conditions prevailing on the market.

The analysis carried out by the authors shows that the criteria for digital transformation include increasing the efficiency of processes, sales and revenues. At the same time, the development of employees and increasing their safety, as well as keeping up with market trends, are considered important. These factors result mainly from digital transformation and changes in the modern world (consequences of the COVID-19 pandemic, inflation, the conflict in Ukraine and the Middle East). Recognizing all internal and external barriers of the company, taking into account technological solutions, allows you to prepare in advance for changes in the future.

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## HOW FUTURE ENTREPRENEURS AND FINANCIALISTS ARE EDUCATED AT THE UNIVERSITY OF ECONOMICS IN KATOWICE – SURVEY RESEARCH FROM THE TIME OF THE COVID-19 PANDEMIC

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**Purpose:** The paper aims to outline the issues related to the teaching methods used when educating would-be entrepreneurs and financialists during the COVID-19 pandemic. It focuses, in particular, on the results of a survey conducted among the students of Entrepreneurship and Finance at the Faculty of Economics, the University of Economics in Katowice. The deliberations discussed here primarily refer to the case-study method. The paper also constitutes an attempt to present the advantages and the drawbacks of selected teaching methods.

**Design/methodology/approach:** The main research technique used in the studies is a questionnaire survey. It was further supplemented with face-to-face interviews. The research covered students of graduate programmes, mostly in-service ones and having practical knowledge in their field. A review of scientific literature was followed up with the survey. The paper utilises the methods of synthesis, as well as the fundamentals of deduction. The author also drew on his own knowledge and many-year experience gained when working with business students seeking practical knowledge. Entrepreneurship and Finance is a practice-oriented degree course.

**Findings:** The paper verifies empirically the knowledge presented in the scientific literature. The research findings addressed here may be seen as a pilot survey.

**Research limitations/implications:** The research outlined here concern selected teaching methods. They cover a small number of students following a full-time program. The respondents, however, were university degree holders, with the vast majority of them being in-service students, i.e. already employed in business.

**Practical implications:** The results of the questionnaire survey may help to improve the methodical tools used in the education of business students who follow practical courses. After all, the knowledge conveyed to future entrepreneurs and financialists must be based on practical aspects.

**Originality/value:** The paper may be seen as casting light on the process of educating would-be business and finance professionals at a business university. The outcome of the research underlying the paper may serve to enhance the teaching techniques used when delivering programs to students. The content of the paper may also be seen as a valuable insight into students' – rather than tutors' – perceptions of the issues. The paper also indicates the advantages and the drawbacks of the teaching methods used during the COVID-19 pandemic, including e-learning.

**Keywords:** Entrepreneurship and finance, business university, teaching methods, case-study analysis, survey research.

**Category of the paper:** Research paper.

## 1. Introduction

The education of future entrepreneurs and financial specialists seems to be a challenging task. One of the reasons for that is the fact that economics belongs to applied sciences. As a result, academic teachers have a number of challenges to address, some of which are caused by a constant development of knowledge in the field of education as well as the emergence of new and unexpected situations, such as the COVID-19 pandemic, in the environment where business universities operate. Consequently, a teaching process at universities in Poland and worldwide needed to be adapted and conducted in a way which differs from the previously established ones. In particular, the COVID-19 pandemic affected the methodology used by academic staff. The commonly implemented formula of remotely conducted classes has become a routine way of working, which, to a large extent survived and continues to be used in the post-pandemic times. What did the education of future business people and financial specialists look like during lockdowns and sanitary regimes, which were generally imposed, and what conclusions may be drawn from that experience? This paper is an attempt to find answers to these questions.

The paper aims to present the results of the survey questionnaire conducted among the students of Entrepreneurship and Finance at the Faculty of Economics, the University of Economics in Katowice. The deliberations contained here focus on the applications of teaching methods in the process of educating future entrepreneurs and financialists, in particular the use of case studies. The objective of the paper is also to outline the advantages and the drawbacks of the selected teaching methods used during the COVID-19 pandemic (Garwol, 2022). Management and quality sciences, similarly to economics and finance, offer a wide array of methods that may be employed to carry out research but also to teach students. The range of methods on hand is exceptionally wide due to economics being an applied science, as stated above. Therefore, both the applicability and the utilitarian aspects of such knowledge are important.

The survey was conducted in January 2022, i.e. at the time when the University of Economics organised its classes and lectures by adopting a hybrid formula. The research covered full-time students of a graduate program in Entrepreneurship and Finance. The vast majority of the respondents were university degree holders already working in business. The research tool of a questionnaire was used; and it was conducted in a direct way. It was supplemented with face-to-face interviews. The respondents were 37 students,



who answered the total of 17 questions; part of which were open ones. The research may therefore be regarded as a pilot study.

The author of the paper draws on his expertise and experience gained from his many-year work with students of the University of Economics in Katowice, in particular in practice-oriented degree courses. Entrepreneurship and Finance is such a practical course. Consequently, the paper is of the empirical character and it is based on a review of the scientific literature in the field.

## **2. On the theoretical background to the teaching methodology used at business universities – at attempt at a synthetic presentation of the issue**

Both in theory and in practice there is a commonly shared belief that for effective and successful teaching of students we need to be able to apply appropriate teaching techniques (Kember, 2009). What is particularly important is the ability to employ a whole range of teaching methods in a complementary way. The scientific literature addresses this issue in a broad and detailed manner. What can be done here, therefore, is to try and synthesize this knowledge. In general, „(...) a teaching method is intended to help us to pursue the operational objectives of teaching (Brophy, 2002), hence it is connected with the need to fulfil at least the three conditions:

- specify the ability which [a student] should acquire as a result of the applied method of work,
- specify in detail and name an activity which [a student] will have to carry out to make sure that the objective of a class is to be achieved,
- create the conditions to accompany the process of teaching (Traszka, 2005).

In theory, the educational methods can broadly be divided into expository, inquiry-based and practical methods (Turos, 1999; Nalaskowski, 2000; Kupisiewicz, 2000; Kawecki, 2000; Bereźnicki, 2001; Pólturzycki, 2002; Okoń, 2003; Pilch, 2003; Zawadowska, 2004; Richardson, 2005; Okoń 2007; Bereźnicki, 2015; Ziółkowski, 2015). The last group of methods are particularly relevant for the successful conduct of teaching processes in business degree courses. Another classification of methods quoted in the literature is the division into, first of all, knowledge assimilation methods, which are based primarily on cognitive activity of a reproductive character; secondly, independent investigation to acquire knowledge, i.e. inquiry-based methods, also known as problem-related ones, based on creative cognitive activity, involving solving of problems, and thirdly, value adding methods, also known as expository ones – where emotional and artistic activity plays a dominant role; fourthly, practical methods – with practical and technical activity being the prevailing one (Okoń, 2003; 2007). It should be noted that business universities most frequently deliver their courses in form of

lectures and classes. In particular, expository methods (lectures) involve students being provided with knowledge, allowing them to gain the ability of noticing and writing down most important information (Michalski, 2001). Inquiry-based methods, in turn (brainstorming, didactic games) require students to identify and then solve a problem (Michalski, 2001). Practical methods (internship) indicate that students are educated through practical actions (Nalaskowski, 2000; Bereźnicki, 2001; Michalski, 2001; Pólturzycki, 2002; Pilch, 2003; Zawadowska, 2004; Richardson, 2005; Okoń 2007; Ziółkowski, 2015; Bereźnicki, 2015). In general, „(...) in order to select the right method [an academic teacher] may follow the questions listed below:

- what is the potential interest of [students] in the topic?;
- how well previously taught material has been acquired?;
- what technical means may be used during classes?;
- to what extent can [students] prepare at home?;
- can correlation between subjects be used?;
- can the selected teaching method be used for a given topic?;
- can the selected teaching method be used under the organisational conditions?;
- can outsiders (e.g. banking practitioners) participate in a class?;
- how to motivate [students] to actively participate in a class?;
- how to construct a self-evaluation test [for a student]?;
- how many [students] participate in classes? (important when dividing a group into smaller teams)?;
- what activation method to choose? – in compliance with the one-class-one-method principle;
- how to design a tool for measuring activity demonstrated [by a student] when working in a team?;
- how to evaluate work in order to motivate [students] rather than putting [them] under stress?” (Trzaska, 2005).

In management and quality sciences as well as in economics and finance special importance is attached to a case study analysis (Pizło, 2009; Matejun, 2011; Kożuch, Marzec, 2014; Gawel, Pietrzykowski, 2014; Czakon, 2015). Looking at this technique in the field under research it should be noted that this is „(...) a research method which provides a broad description of a given phenomenon, aiming to conduct its in-depth analysis and evaluation; using a number of techniques to collect and analyse data and helping to solve scientific and practical problems” (Grzegorzczak, 2015). In particular „(...) this method may be used to reconstruct the course of a given phenomenon, in order to outline the conditions and the factors which affect it; in this case (...) we deal with enhancing the knowledge about the phenomenon, which is not fully defined” (Mielcarek, 2014). On the other hand, case studies are commonly used in teaching in business universities; the application of the method is fairly wide, i.e. starting from

lectures, through classes and ending on writing of bachelor and master theses. It's worth adding here that in the scientific field this method is regarded as a qualitative method of conducting research (Konecki, 2000; Creswell, 2009; Pizło, 2009; Matejun, 2011; Kożuch, Marzec, 2014; Gawel, Pietrzykowski, 2014; Czakon, 2015), while from the didactics point of view this method belongs to inquiry-based ones (Trzaska, 2005; Jaques, 2008; Zelek, 2021).

No matter how they are used, however, case studies – just like other methods applied when educating business students – require the understanding of their pros and cons. The advantages and the drawbacks of this method are listed in Table 1.

**Table 1.**

*Advantages and drawbacks of a case study analysis as a method used in teaching of students*

Item	Teacher	Students
Strengths	Getting to know students and their abilities Easy to motivate learners Evaluation of solutions offered by teams Evaluation of activity No physically demanding and not stressful Direct supervision over work Easy to correct mistakes Improvement of techniques and tools	Highly motivated to work Very active Encouraged to be creative Need to manage time well Getting to know the reality of a profession Acquiring practical skills Integration in a team No stress
Weaknesses	Difficult to control discipline Time-consuming preparation The need to update knowledge from a number of areas	Varied pace of work of different teams and individuals Some individuals not active Copying solutions proposed by other teams Lack of critical evaluation No discipline Noise

Source: Trzaska, 2005.

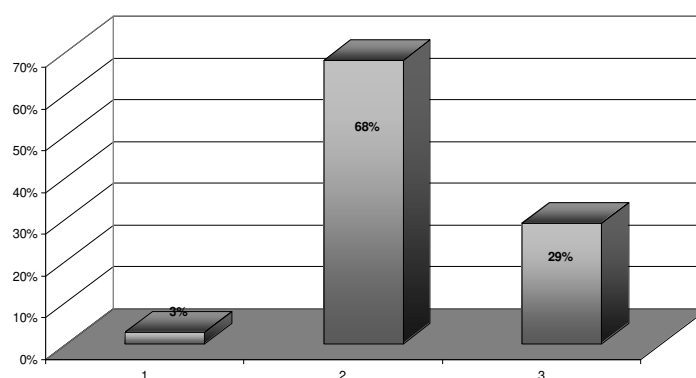
In didactics this method tends to be used to complete the subject, on one hand, and to summarise a portion of the material covered with students, on the other hand (Trzaska, 2005; Jaques, 2008; Zelek, 2021); it is an inherent part of academic course books. Irrespective of that, however, in March 2020 during the COVID-19 pandemic, all the process of educating students changed, compared to what it had looked like before. It should be emphasised here that scientific literature refers to such events as black swans (Kotnis, 2014; Taleb, 2021; Kisielnicki, 2021; Myrczek, et. al., 2021; Myrczek, Tworek, 2022).

### **3. Application of teaching methods in the process of educating future entrepreneurs and financialists at the University of Economics in Katowice – survey research**

The COVID-19 pandemic contributed not only to almost revolutionary changes to the organisation of work at universities but also changed the way of thinking about work. This is largely connected with remote work in the area of management as such (Wolniak, 2022).

When looking at it in terms of education of future business people and financial specialists at the time of the COVID-19 pandemic, the advantages of classes conducted fully remotely (Garwol, 2022), as indicated by the respondents, include: easy to combine studies and work; mobility; saving time as no need to commute; lower costs of studying; saving time and money; avoiding risky illnesses, health safety; an opportunity to better concentrate on a topic; possible to take part in classes even when one is ill; better presentation of a topic; more rest at home; easier to plan one's time well; not losing time on commuting; easier to focus on a topic. The drawbacks of classes conducted fully remotely, in turn, as indicated by the respondents, include: no face-to-face contact; no team work; problems with internet connection leading to distraction; no contact with other teams; more difficult to motivate oneself to study; no possibility to carry out team projects; no face-to-face contact with a teacher; no opportunity to join a discussion; more difficult to ask questions; no opportunities to socialise. In general, the COVID-19 pandemic made it difficult or students to gain knowledge and skills in a face-to-face manner, which was also reflected in the answers they gave to the question about obligatory internships; in the survey 38% of the respondents said that internships should not be obligatory any longer; the main reasons given to justify their standpoint were the following: most of the students are already in work; internship may make it difficult for the students to perform their work duties; internships are not paid and are often not connected with the degree course the students do; the work they perform should be regarded as internship; employers are not willing to offer internships to students; this is a waste of time; no companies willing to accept students for internships; the university is not engaged in internships; for a company a student – an intern is a nuisance. When responding to the question whether some lectures should be delivered online only, as many as 94% of the respondents gave a yes answer. A mere 6% of the respondents said no; indicating (as the reasons for their negative answers) that, first of all, it is difficult to focus and secondly that online lectures are much less effective.

When referring to the division of teaching methods into expository, problem-solving and practical ones, the research results in this respect are shown graphically in Fig. 1.



*Note.* 1 – expository methods, 2 – problem-solving methods, 3 – practical methods

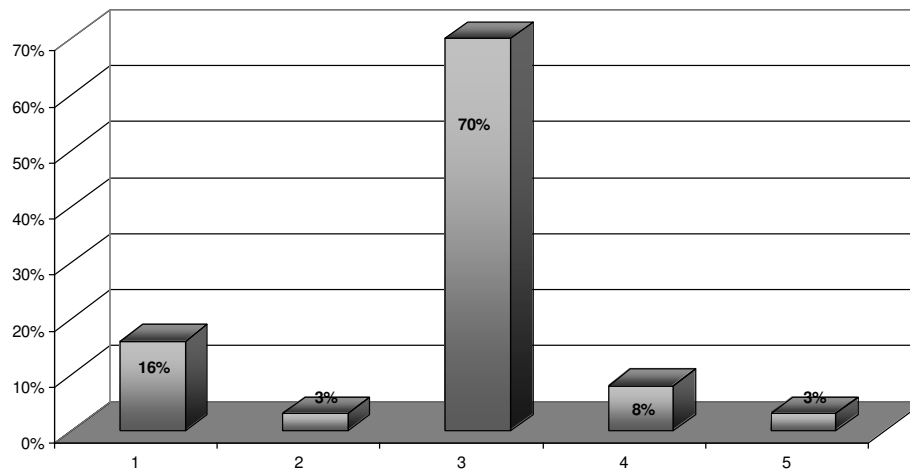
**Figure 1.** Usefulness of expository, problem-solving and practical methods

Source: own research.

As can be seen in Fig. 1 problem-solving methods are the preferred category of teaching methods (68% of the respondents). In the research the reasons for choosing the methods included the following ones: they require an out-of-the-box attitude; give a broader view onto a given topic; they foster and develop creative thinking to the largest extent; they show how to put theory into practice; solutions are worked out together; creativity is stimulated, deeper involvement in a given topic; cooperation between partners is strengthened; everyone may take away what they want from a discussion; they stimulate imagination, they enable teamwork, a topic may be approached from a different angle; easier to remember, another view onto an issue; working together on a project; extending knowledge beyond the topic on hand; an opportunity to compare one's knowledge with other people's, an opportunity to express one's views. The selection of practical methods (29% of the respondents), however, was justified in the following ways: it's easier to understand a task as 'practice makes the master'; it's easier to understand the theory and strengthen this understanding in practice; an opportunity to try the theory out; an opportunity to get to know practice; best test of the theoretical knowledge. The reason given by the respondents who chose the expository methods (a mere 3% of the replies) was that such methods are the oldest, most popular and most commonly accepted ones. The detailed replies to the question of which lecture a student appreciates the most (How should a teacher deliver a class?; What should a teacher do in order to ensure that all the knowledge is conveyed?), the respondents indicated: real life examples, needed in today's world; wider discussion of the issues shown on slides; broad discussion, examples; a mix of various teaching methods; graphic presentation of issues; an opportunity for students to present their points of view; encouraging to take part in a discussion; giving clues on how to understand the topic; showing how theory may be used in practice; providing topics which are current news.

As for the application of case studies in the teaching process – when asked whether academic teachers should support their lectures with examples from business practice, i.e. use a case study analysis – 100% of the students gave yes answers. A very similar result was achieved when responding to the question whether the case study method is useful, i.e. makes it easier to understand the business reality – 97% of the respondents said yes. When asked to provide more details and state what they find most interesting about the case study method and what benefits they see in solving of specific cases, the following answers were given: the method allows students to enhance their knowledge and remember better; specific cases allow students to remember information (knowledge) faster and more effectively; using this method students may solve problems independently, using logical thinking, instead of memorising things by heart and theory may immediately be used in practice; theory may be translated into practice; gaining knowledge about specific cases, becoming familiar with specific companies and solutions; allows students to remember lectured topics better; an opportunity to get familiar with a number of real life cases, which may be encountered in the future; better understanding of a topic; theoretical knowledge may be tested in practice in

an everyday life; actions taken may be analysed; an opportunity to discuss, exchange views; solving of specific cases allows students to draw conclusions which may be useful in the future, it may help them to avoid mistakes; learning from examples; develops creativity, gives a chance to excel. In addition, the respondents expressed their opinions when answering the question of what percentage (of case studies) should there be in relation to strictly theoretical knowledge provided at the university? The results are shown in Fig. 2.



*Note.* 1 – above 50%, 2 – under 50%, 3 – depending on the type of a subject taught, 4 – 50/50, 5 – a subject should be based solely on specific cases from practice.

**Figure 2.** Supporting the teaching process with the use of case studies.

Source: own research.

The results presented in Fig. 2 show that the vast majority of the respondents (78%) expressed the opinion that the percentage of case studies compared to the theoretical knowledge depended on the type of a subject. Not all subjects may be well illustrated with case studies. The remaining respondents think that this figure: should be more than 50% (16% of the respondents), below 50% (3% of the respondents), should be 50/50 (8% of the respondents); only 3% of the respondents think that a subject should be based solely on case studies from practice. Only one conclusion may therefore be drawn – in order to convey knowledge to future entrepreneurs and financialists in a comprehensive way, the knowledge provided to them at university course should be based on organisational practice.

## 4. Conclusion

All the deliberations presented in the paper may be summed up by stating that practical aspects of knowledge delivered to students of business universities, in particular on practice-oriented programs, constitute an inherent component of general knowledge in the teaching process. This is evidenced by the results of the research conducted among students of

Entrepreneurship and Finance. As many as 100% of the surveyed would-be entrepreneurs and financialists said that teachers should supplement their lectures with examples from business practice. In the process of learning new skills and gaining new knowledge the students also prefer inquiry-based methods (86% of the respondents), with the focus on a case study analysis. These results come as no surprise taking into account the applicability and the utilitarian dimension of business knowledge, as mentioned before. In addition, according to the research findings, a particularly valuable teaching method is 'work in field' organised by a lecturer, e.g. showing students round a bank to see what the institution looks like from inside. As many as 81% of the respondents said that this is a good way to support the teaching process. The respondents gave the following justifications: every opportunity to make a program more varied is positive; many students have no possibility to see the inside (of a bank), so this would be a positive experience; an opportunity to compare the theory and practice; increases the imagination; a chance to see in practice what a process looks like from an insider's perspective; an opportunity to give one's plans for the future a direction; strengthening the theoretical knowledge by contact with practice; a chance to see every day work; a chance to get familiar with a potential future place of work. The vast majority of the students supported the idea of inviting business practitioners to classes and lectures on a regular basis, so that the theoretical knowledge can be supplemented with the practical knowledge; in the research this result was 94% of yes answers. The respondents gave the following reasons for their answers: it helps to reinforce the knowledge, to show something more than just the theory, which often does not correspond to the reality; it prepares us to professional work, and, first of all, it inspires us; it shows us what we have learned and confronts it with practice, it's an opportunity to ask people 'in the trade' some questions; contact with practitioners allows us to understand the theory and makes it closer to the everyday life; it facilitates the teaching process a lot and encourages students to take active part in classes, it motivates and inspires; it's a more interesting formula than just listening; students may see the theoretical knowledge translated into practice; it shows a potential career path; it's easier to learn new material; it's an opportunity to find out how theory may be used on an everyday basis; it's an opportunity to gain practical knowledge already when studying at the university and on theoretical classes; it allows students to see the difference between theory and practice; we may see how theoretical knowledge is translated into practical actions and everyday work.

Finally, it should clearly be pointed out that the COVID-19 pandemic not only changed organisational routines and practice in business universities but it also contributed to a shift in the way of thinking about the usefulness of some teaching methods. In particular, this should be applied to a remote form of delivering classes and lectures (Garrison, Vaughan, 2008; Mokwa-Tarnowska, 2015; Pokrzycka, 2019; Garwol, 2022). In the research future entrepreneurs and financialists stated that according to 94% of them some lectures may be delivered online only. In order to implement the changes suggested by students business

universities in Poland have permanently adapted the way they conduct classes; the current standard is a hybrid formula of providing educational services.

The author of the paper hopes that its potential readers may find here an inspiration to encourage them to conduct some broader empirical studies of this issue. This may clearly be a research task for the future, as this paper addresses just a small section of the vast knowledge in this area.

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## KNOWLEDGE MANAGEMENT IN NEW PRODUCT INTRODUCTION BEFORE AND DURING THE SARS-COV-2 PANDEMIC

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**Purpose:** The purpose of this research is to assess the importance and difficulty of particular knowledge management processes in the NPI before and during the SARS-CoV-2 pandemic. The focus of interest are the issues of knowledge flow in the organization, concerning creation and exchange of knowledge and the relationship between knowledge management practices and the creation and introduction of new knowledge in NPI.

**Design/methodology/approach:** The methodology is based on structured individual interviews that were conducted with 12 employees of companies involved in NPI processes. This format allows for better understanding and assessment of KM processes and reasons for change. The interviewees were inquired directly about the importance and difficulty of the KM processes.

**Findings:** The results have confirmed the crucial role of Knowledge Management in NPI. The processes of knowledge sharing and knowledge application are of greatest importance. The pandemic has affected knowledge flow processes; however, the perceived importance of individual KM processes during pandemic has not changed significantly, yet coding and knowledge-sharing processes require more attention.

**Research limitations/implications:** Results may not reflect the entire NPI field due to limited number of interviewed companies. It is advisable to carry out research that will take into account the division into different areas of companies' activities and analyze other processes of knowledge management.

**Practical implications:** The results are useful for adjusting by enterprises the KM processes to meet the changing conditions during NPIs, especially in the context of remote working.

**Social implications:** By adapting the KM in NPI to the presented current circumstances companies may improve not only the business outcomes, but also the well-being of employees, as a results of decreasing their stress connected with inadequacy of work processes to the real requirements.

**Originality/value:** Based on quality research, the article shows trends emerging in the KM during the NPI, which are useful for companies that run New Product Introductions, as well as for researchers by providing a starting point for further research.

**Keywords:** knowledge management (KM), new product introduction (NPI), new product development (NPD), SARS-CoV-2 pandemic, quality research.

**Category of the paper:** research paper.

## 1. Introduction

Knowledge management (KM) refers both to a business practice and to a theoretical field of study. In the last 20-30 years, a number of researchers in management field have focused on knowledge management (e.g. Nonaka, Takeuchi, 1995, Probst et al., 2002, Jemielniak, Koźmiński, 2008), many of them in the context of knowledge management in Research and Development (R&D) projects (Szczepaniak, 2016; Kerssens-Van Drongelen et al., 1996) and in the New Product Development (NPD) process (Cantamessa, Montagna, 2016; Subramaniam, 2006).

However, very few studies have focused on the knowledge management in the New Product Introduction (NPI) component of projects, despite its great importance to the success of companies bringing new products to the market (Damanpour, 1991; Subramaniam, 2006).

The aim of this study is to evaluate the importance and difficulty of particular knowledge management processes in the New Product Introduction before and during the SARS-CoV-2 pandemic. This area deserves research especially because it is often at the NPI stage of the project that the knowledge management process needs to be adjusted and different elements emphasized than during the development of the product being introduced. This issue is of particular interest in the context of pandemic changing ways of working and collaboration of teams involved in knowledge management and NPI processes, mainly in technology companies.

For this purpose, an empirical study was conducted among companies dealing with NPI, to answer the following research questions:

1. What are the assessments (in terms of importance and difficulty) of the key processes of knowledge management affecting NPI before and during the pandemic?
2. Which of these KM processes have gained in importance or difficulty, which have lost, and which have remained the same?
3. What are the reasons for the changes?

This article focuses on the issues of knowledge flow in the organization, notably on exchanging and creating the knowledge and the relationship between knowledge management practices and the creation and application of new knowledge in NPI. It is crucial to determine how persistently the company uses internal knowledge in new product launches.

The structure of the article includes a systematic review of the literature in the area of knowledge management in the NPI process, the methodology of research, its results and a discussion with recommendations for the use of its findings.

## 2. Theoretical background

KM can be defined as *an effort to increase useful knowledge within the organization. Ways to do this include encouraging communication, offering opportunities to learn, and promoting the sharing of appropriate knowledge artifacts* (McInerney, 2002, p. 1014) or – in a more process-oriented perspective – as *the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities* (Quintas et al., 1997, p. 387).

Some of the most significant researchers in the knowledge management field (Nonaka, Takeuchi, 1995), make a distinction between tacit and explicit knowledge. Tacit knowledge is based on experience and is difficult (or even impossible) to communicate. Explicit knowledge, on the other hand, is knowledge that can be verbalized, coded, and communicated, so it can be easily shared. There is a process of transforming tacit knowledge into explicit knowledge (Nonaka, Takeuchi, 1995). In fact, the concept of knowledge management is most often viewed as a process perspective. Thus (despite the lack of a unified vocabulary), the terms "KM processes" or – usually more detailed – "KM elements" are most often used.

Classically, knowledge management processes have been defined as follows: locating, acquiring, developing, sharing and disseminating, using and keeping knowledge (Probst et al., 2002). However, Abubakar (2019) defined six knowledge management processes:

- Knowledge creation process includes an organization's ability to formulate knowledge into its services, products, and systems.
- Knowledge capture process is the process of replacing existing knowledge, with newly acquired knowledge.
- Knowledge organization process is related to the process of structuring and sharing knowledge.
- Knowledge storage process is a mechanism to store and retrieve knowledge as needed.
- Knowledge dissemination process refers to the transfer of knowledge between entities.
- Knowledge application process involves using it in action, problem solving, linking, etc.

Park & Kim (2006), based on the conducted literature review, suggest the list of major knowledge activities consisting of five elements: acquisition, organization, utilization, disposition, sharing. Relating to the activities, they propose more detailed knowledge management functions or tools: knowledge portal, document management system, information retrieval system, workflow management system, collaborative system and analysis system (Park, Kim, 2006).

It is advisable to use these different perspectives when considering the importance of individual elements of the knowledge management process. They may be developed and refined depending on the nature of the project and the characteristics of the analysis, as in Szczepaniak (2016).

The importance of all this KM processes/elements can be evaluated in the NPI stage of the project. Knowledge management methods need to be selected and evaluated depending on the purpose for which knowledge is “being managed” (Hoegl, Schulze, 2005).

It is well documented in the literature of the topic that introduction of new products and services is a critical determinant of organizational performance and survival (Damanpour, 1991). Because NPI is one of the main sources of competitive advantage for businesses, the NPI process has to be clearly described and followed by the engaged people. Models are a useful aid to communication and understanding when studying a process. Over three decades of research provide notable insights on how organizations structure and procedurally manage their new product introduction processes. There are various NPI models, the most common of which are: Departmental-stage models, Activity-stage models, and Decision-stage models (Saren, 1984).

The Departmental-stage models are the oldest and are characterised by the ‘functional’, ‘sequential’ and ‘over the wall’ approach for NPI. The focus is on the functions that are responsible to carry out each stage (Kennedy et al., 2003). The Activity-stage models of NPI offer a better view of the process since they focus on the activities that are carried out. Activity-stage models and their extension, decision-stage models, are the models that have been most rigorously investigated and used. Booz, Allen and Hamilton (Booz, Allen, Hamilton., 1982) described one of the first examples of activity-stage model. The Decision-stage models have various names in practice: Phased Project Planning, Gating System, Stage-Gate Systems or Phase-Gate Systems etc. Their characteristic is that the process consists of Stages which are always followed by Gates (Cooper, 1994). It is also made obvious that the NPI process is closely related to Project Management. The project leader drives the project from stage to stage, gate to gate (Cooper, 1994).

New product introduction, although it is a difficult process and involves high risk, is likely to turn into huge benefits such as increasing market share, improving sales of existing products to retain customers or the services the company needs to provide to increase financing and to keep its doors open.

The integration of knowledge from multiple sources, while widely regarded as fundamental to new product launches, remains unclear and presents a serious challenge for organizations. A key premise underlying this research is that the effective sourcing, sharing, and assimilation of cross-disciplinary knowledge are essential for new product capabilities. Enhanced knowledge integration exposes itself as product development or introduction opportunities as it directly affects their core attributes: consistency, frequency, simultaneous market introduction and market success (Subramaniam, 2006).

There are solid approaches to the NPI advanced in the literature, which showing the necessity of understanding the complexity of and communication linkages in the process and departments engaged in the process itself. Authors such as Bergen (1988) Langowitz (1989), Voss & Winch (1996) defined launching of new products as cross-functional coordination and collaboration between various departments pointing out marketing, NPD, and production. Further, Knudsen (Knudsen, 2007) and Ryall (Ryall, 2013) extended this definition as inter-organizational collaborative arrangements, i.e. collaboration with customers, suppliers and even competitors, as they allow companies to develop products faster and offer greater product variety. Cantamessa & Montagna (2016) provided the opinion that NPD process of a company is often described in an analytic model for an innovation process. NPD is a business process that a company performs to deliver innovation to the market.

The above definitions of introducing new products to the market have been found in the literature of product and project management. Comparing one definition with another, it can be seen that they examine interdisciplinary activities, relations between departments or even companies and close cooperation within several departments.

Knowledge integration in these kind of approaches is the cornerstone of successful new product launches (Subramaniam, 2006). In such a process, knowledge can enter from various sources. Every effort to add value is welcomed. Self-engagement and willingness to acquire exchange and re-apply knowledge is becoming crucial capability at the individual and organizational level. Creating an environment that allows a smooth transition and replacement of skilled workers is one strategy that can provide a competitive advantage to a company by creating a continuous knowledge exchange, building and strengthening the knowledge base, and reducing the risk of knowledge loss in employee turnover. The development of a knowledge management framework for an enterprise on the continuous development of both individual and enterprise knowledge is associated with the successful implementation of a new product (Pendevska, Poposka, 2020).

To identify the gap, the present study uses a systematic literature review to investigate the factors that influence knowledge management when introducing new products to the market. The systematic literature review was selected in order to conduct a higher quality, more comprehensive, extensive, and unbiased literature review. This is a clearly defined method for identifying, selecting, validating and incorporating information from the literature to be clear, transparent, recordable and reproducible. Snyder (2019) advocates that this systematic review should focus on a specific research questions and evaluate quantitative articles in terms of policy and practice. The systematic review approach is widely used by researchers (e.g., Petticrew, Roberts, 2008; Tranfield, Denyer, Smart et al., 2003).

At the initial stage, keywords and term identification are conducted to facilitate data extraction. This stage is based on key terms related to factors influencing knowledge management and new product introduction. The researchers used the following keywords to guide searches on the databases: knowledge management, new product introduction, NPI,

new product launch, new product development. The goal was to use the fewest number of concepts as possible to maintain a manageable set of results in the keyword searches. Journal articles, research studies and books were reviewed.

The review of the available literature has been performed in April 2022 in the EBSCOhost database, which includes the following databases: Academic Search Ultimate, Business Source Ultimate, Masterfile Premier, Newspaper Source, Open Dissertations, Regional Business News, Teacher Reference Center, Master FILE Reference eBook Collection. The search strategy was as follow, a table was created listing the keywords listed in each study; and as new keywords were found, the search strategy was revised using those terms. The search was rerun and documented taking into consideration only full text articles. The goal was to create an optimal search strategy to obtain useful literature citations. This process was performed for each article found based on an abstract search method. Therefore, this work represented a comprehensive systematic literature review of selected empirical studies.

Table 1 shows the combinations of keywords that were deemed of primary importance from the standpoint of this study. The first conclusion that can be drawn is that those combinations yielded a more concise list of publications related to the main research topic. Combination of two main definitions of this study, so the knowledge management and new product introduction (NPI) new product launch show that number of publications appears to be rather limited, and therefore this issue is worthy of further consideration. On the other hand, the knowledge management approach seems to be widely discussed in the literature on the subject in the area of new product development. In addition, new product development (NPD) is complex and is becoming more so. It depends on testing various new product ideas and settling on the possible best option. As a result, the problems we are dealing with in this study can be perceived in many ways as new.

**Table 1.**

*Selection criteria for literature review*

<b>Selection criteria (in abstract)</b>	<b>Number of identified articles</b>
<b>Knowledge management AND New product introduction</b>	12
<b>Knowledge management AND NPI</b>	1
<b>Knowledge management AND New product launch</b>	9
<b>Unique articles</b>	20
<b>After an abstract verification</b>	7

Source: Authors' own work based on a database search.

The results of the search performed were reviewed. The first review was based on abstract verification and the total number of articles, which are included in the further literature review, equalled 7. The criteria, for excluding the rest of the identified sources, is based on research main subject (knowledge management in new product introduction during and after pandemic (COVID-19) and research questions. The number of similar studies is limited because of the pandemic recent event.



In addition, systematic literature review shows a research gap in combining knowledge management and NPI areas, but existing articles indicate that this is a field possible to research. It is required to reference the literature from the KM and NPI areas separately and combine them into a new perspective.

Moreover, this study directly assess the influence of the COVID-19 pandemic on managing knowledge in case of new product launches. The data for the study was gathered during the pandemic period, as such, the results of this present study could offer some practical clues on how firms could achieve competitive advantage during the outbreak of pandemics.

The most important conclusions from the selected articles highlight the rate of new product and service introduction is strongly connected with the organization members' ability to combine and exchange knowledge (Smith, Collins, Clark, 2005) and there is a need for sharing various types of knowledge on different business levels (Herder, Veeneman, Buitenbuis, Schaller, 2003). The authors focus on the importance of knowledge management factors and practices to show how the companies depend on the knowledge management system in enhancing NPD performance (Inganäs, Hacklin, Plüss, Marxt, 2006).

Based on the theory of knowledge management, the authors present a conceptual framework that synthesizes various random factors. The analysis reveals that involving customers in the ideation and launch stages of NPD and KM improves product performance directly as well as indirectly through acceleration of time to market (Chang, Taylor, 2016).

Another study (Valentim, Lisboa, Franco, 2016) aims to identify and categorize knowledge management practices, which companies can adopt to develop absorptive capacity. The authors concluded that companies engage in knowledge management practices by collaborating with business partners, favoring experience-based learning processes, knowledge transfer to employees, and knowledge absorption by employees, which helps them to increase efficiency, strategically adapt and introduce new products and services, It is important to investigate how a companies' achievement of new product introduction is related to the adoption and knowledge management experience sharing within a company and with customers/suppliers (Intalar, Jeenanunta, Rittippant, Chongphaisal, Komolavanij, 2018).

In the face of challenges related to reacting to the novelties of the changing business environment (e.g. new customer requirements, changes in customer tastes and preferences, the introduction of new products or services by competitors), organizations try to build cooperation among their employees who have complementary knowledge. The integration of complementary knowledge increases the ability of employees to cope with environmental challenges and foster innovation (Acharya, 2016).

The following knowledge management processes were identified as the most important in the selected literature:

1. Knowledge absorption/acquisition.
2. Knowledge integration and coding.
3. Knowledge transfer/sharing.

4. Knowledge creation.
5. Knowledge application/usage.

### **3. Research Methodology**

Structured individual interviews were conducted with employees involved in NPI processes. An interview format was chosen to understand better assessments of KM processes and reasons for change, as well as possible connections between different aspects of the processes studied. The purpose of the interviews is to evaluate the different processes involved in knowledge management during the New Product Introduction process. Specifically, the processes of knowledge absorption/acquisition, knowledge integration and coding, knowledge transfer/sharing, knowledge creation, and knowledge application/usage during the NPI process were analyzed. The assessment focus at how important these processes were/are and which were/are the most challenging before and during the SARS-CoV-2 pandemic. The interview also aims to identify reasons for changes.

Taking into account the issues identified in the subject literature, direct questions were asked about the importance of the aforementioned five KM processes (which were discussed in the articles identified in the systematic literature review), with a possibility of coverage other KM processes considered important by the respondent, and additionally, about the overall significance and benefits of knowledge management during the NPI, as well as about the most challenging KM processes during the NPI.

Interviews were recorded to analyze responses accurately and avoid mistakes, as well as to use exact quotes if needed. Respondents were assured of anonymity and that their statements would not be linked to personal data; after which they consented to the recording of the interview. Respondents were also informed about the objectives of the study.

The interview included 9 questions (some of which consisted of sub-questions) and lasted approximately 25 minutes. The interviews were conducted by the authors of the paper in 2022, with 12 employees of Polish companies involved in NPI, by phone, at a time convenient for the respondent.

### **4. Research Results and Discussion**

All respondents confirmed the fundamental importance of Knowledge Management, both in the New Product Development process in general, and in particular in the New Product Introduction process:

*Knowledge management is very important in a general sense, because it allows to document and consolidate processes, but it also allows to go back to a given body of knowledge to use it, to develop it, to improve it.*

*Without knowledge management various problems come out at the NPI stage and you have to go back to earlier stages – which causes the company's loss.*

*The essence and benefit of knowledge management in the NPI process is to confirm if the product is really desirable by the market or if the producer just wants it to be.*

However, respondents varied in their ratings of the importance and difficulty of specific KM processes and the impact of the pandemic. These differences were primarily in evaluations of the integration/coding and knowledge transfer/sharing processes and were due – at least partially – to respondents' different experiences: representatives from companies that had not practiced remote working prior to the pandemic indicated a greater impact of the pandemic than representatives from companies that had already developed mechanisms for effective remote coding and knowledge sharing.

The knowledge acquisition process was typically rated as less important in the NPI stage. Although the process is not insignificant (e.g., gathering information from customers is still important), it was pointed out that the importance of this process is much greater in the initial stages of New Product Development, than in the NPI stage (which is the final element of the broader NPD process). However, some respondents claim that this is a key process in NPI, yet it was understood by these individuals as a process of acquiring knowledge only about customer requirements for the final product design (so it involved a limited range of knowledge):

*[Knowledge acquisition in NPI] is very important because it allows us to both gather and confront knowledge – to come to a situation where our understanding of the product and the customer is better, so it allows us to eliminate problems in product introduction.*

The pandemic did not affect the perceived importance of the process, although made it more difficult:

*Knowledge acquisition is equally important (...). [The pandemic] forced us to rebuild different working models (...) and to intensify the search for knowledge.*

During the pandemic, it was possible to notice a variety of activities supporting effective knowledge management, carried out with the use of modern forms of communication:

*Knowledge transfer became particularly important during the pandemic, when employees operate in a dispersed position. Under these conditions, traditional methods of knowledge management have lost their purpose. The tools used to obtain knowledge have changed. In a situation where everyone worked remotely, people initially encountered difficulties with the exchange of information. quick and efficient adaptation of the process of acquiring knowledge to new conditions and limitations during a pandemic.*

It was typical for people with the experience of NPI process in pre-pandemic times to assess the impact of the pandemic on the effectiveness of communication and knowledge transfer in the process:

*The importance of awareness and knowledge to the NPI process has increased over the course of the pandemic. This was due to the possibility of longer conversations, faster contact with the co-worker (teleconferences) as well as recognition by all team members and sub-teams that understanding the other party and obtaining this knowledge may result in improved communication and avoiding errors and misalignments during the NPI process.*

Knowledge integration and coding was not rated as particularly important in NPI. This process is generally treated subordinately to other KM processes, and in small teams the flow of knowledge is often so smooth and easy that knowledge integration and coding procedures are not necessary. Nevertheless, this process is not considered completely unimportant, because:

*If we encode knowledge, we can go back to it, use it, improve it.*

It was also pointed out that during the pandemic the encoding of knowledge became more important:

*The process advanced (...) [due to] the readiness that at any time our colleague can get affected by Covid and 'fall out of loop', hence the importance of integration and coding of knowledge increased,*

and also because of its more difficult flow:

*Contacts have loosened up, there are no personal meetings, thus knowledge needs to be transmitted in a more structured way – in coded form indeed.*

In this case, the evaluation of the importance of the process was linked to the evaluation of its difficulty.

It is extremely important to develop knowledge in the company based on experience and successful implementations in a past. If the process of knowledge coding advances along with the development of technology, the method of obtaining information will be easily digestible and accessible to users:

*When applying the codification strategy, the enterprise relies on explicit knowledge. Therefore, employees use the knowledge previously developed in the company and are encouraged to supplement it with their own observations and experiences gained during the implementation of projects. Assuming above, the pandemic and remote work did not have a negative impact on the process of integrating and coding knowledge.*

The use of modern technologies makes it possible to reach a wider group of people involved in the process, including participating in virtual space, e.g. conducting remote meetings or using platforms that enable tracking the current implementation status. NPI's virtual space has become much more popular, mainly during the pandemic, when companies started using online platforms to share data with customers:

*During the pandemic, this process was carried out online, remotely and developed in this direction to a greater extent. It is just as important as before and after the pandemic, only in an altered form.*

*Knowledge transfer is largely virtual, but the pandemic had a certain impact on the process, mainly due to communication difficulties, i.e. the inability to conduct a "quick" meeting in the office to discuss current topics related to the NPI project. The process of sharing knowledge is very important in NPI processes. Incorrect information provided in the initial phase of implementation may cause a snowball effect and have a very large impact on the success of the entire project.*

Knowledge transfer/sharing is a process that is important at every stage of a project, including NPI. The pandemic made the process more difficult, due to limited opportunities for in-person meetings among team members and impeded communication:

*With in-person meetings, you could immediately deduct whether someone has or hasn't understood; and with online meetings: whether with cameras or even without cameras, you aren't really even sure if anyone was listening.*

*The risk of misunderstandings and errors in this process increased.*

Nevertheless, its importance in the assessment of almost all respondents has not changed: it is perceived as very important both before and during the pandemic.

The importance of this process in NPI was rated differently by various respondents. This indicates differences in the perception of the importance of this process in NPI. Some respondents assessed it as crucial for NPI, while others indicated that, as in the case of the knowledge acquisition process, at the NPI stage it is "too late" to create new knowledge, as this process should mainly take place at earlier NPD stages:

*[in NPI] we already have a product and we only refine it, while we do not create new functionalities anymore,*

whereas NPI is a project stage where it is much more important to use the created knowledge effectively. Knowledge creation, however, has become somewhat more important in a pandemic:

*Before the pandemic we had processes already working, and during the pandemic some became obsolete and new ones had to be created, so the importance of knowledge creation increased.*

The perceived difficulty of the process did not change.

Due to the imposed communication restrictions, team representatives could continue their activities in the area of NPI, bearing in mind the proper allocation of knowledge about the risks and threats caused by the pandemic:

*During the pandemic, when we usually deal with new threats, it is very important to conduct rapid and thorough research in order to build knowledge about the threat and eliminate it as quickly as possible or at least reduce the risk of the threat.*

However, in terms of the creation knowledge during NPI process, it was always very crucial to document and save all of details required for the successful execution of the process. The same approach is applied for all of the changes appeared during the NPI process. It is a very complex and dynamic process, where each change can be significant for a successful implementation. Therefore, it is necessary to track the changes on a regular basis and make sure they are documented and well known to the team:

*Knowledge creation in the NPI process is particularly important in the initial phase of a project. It is the basis for further stages of the implementation process. Correct data allows for the timely and, above all, effective introduction of products to production. The pandemic did not affect the relevance of this process.*

All respondents agree that this is a crucial process in NPI:

*It is one of those key processes that can determine the success or failure of the product being implemented.*

*The application of knowledge in the context of new product introductions is critical and this has not changed at the time of the pandemic,*  
and all of the discussed processes are used to ensure that knowledge is applied effectively in the NPI stage:

*That's what all those previous processes were for: to use that knowledge – that's what we did those activities and actions for: to implement the knowledge.*

As in the case of the knowledge creation process – the pandemic is unlikely to have had a significant impact on the difficulty of this process, but the knowledge application/usage is generally seen as the most important in the NPI, as well as being a significant challenge.

It can also be pointed out that the pandemic has further emphasized the importance of using knowledge that is passed on from reliable sources:

*It seems to me an obvious statement that building supporting processes or improving the existing ones is connected with skillful use of knowledge gathered from previous implementations and experiences. Without using knowledge, there is no point in building or acquiring knowledge / information if they are only to be archived.*

*The use of knowledge is a positive value in the process, which allows the implementation process to run smoothly and for all users to know exactly the requirements, expectations and the implementation process.*

Respondents' answers confirm and expand on the findings of previous research on the subject. Respondents did not indicate that any other KM processes were of particular importance in NPI, although the general need to evaluate knowledge and to treat knowledge management in an iterative manner was noted. KM cannot be performed in a waterfall way because the knowledge required for new product development and introduction changes dynamically, so its acquisition, integration, etc., should be performed continuously with special attention to its quality and completeness:

*For example, people's expectations, their routines, some habits before the pandemic were different than after, so iteration helps to verify whether a product is still desirable in the market, whether some things happened that made people no longer need it or would like to use it differently.*

As indicated above: during the pandemic increased especially the difficulty of knowledge sharing and the process is perceived as one of the most difficult now. The second is creating new knowledge. In most cases, it concerns the early phase of the implementation process. This is the first stage on which further processes are built. Without it, they cannot work properly.

*These are the most difficult processes, because the research needed to create knowledge, it is very complicated and takes time, often the results of research are ambiguous, which further complicates the creation of knowledge. In acquiring both new and existing knowledge, there is always a risk that the knowledge is not entirely true or has been gathered from unconfirmed sources. A perfect example is the internet, where virtually anyone can post information.*

Concerning the processes that were perceived to be the most difficult before the pandemic, most respondents had difficulty identifying the processes that were previously the most challenging. One respondent provided the following explanation, which seems to accurately explain this fact:

*Before the pandemic we had already developed and tested procedures for everything; we were already used to a certain way of working and the methods were known.*

## 5. Conclusions

KM is an extremely important aspect of NPI, as well as – more broadly – NPD. Effective knowledge management enables effective introduction of new products that truly address customers' needs.

The pandemic has affected many aspects of work, changing knowledge flow processes in many companies. Industries such as IT that had previously adjusted to remote working were less affected by these changes, but every company had to adapt to the new conditions, including increased emphasis on knowledge security in general (Wisniewska, Wisniewski, 2019). In particular, coding and knowledge-sharing processes require more attention. However, the perceived importance of individual KM processes has not changed significantly. In NPI the processes of knowledge sharing and knowledge application are of greatest importance, so that an introduced product meets the customers' needs. Knowledge management, on the other hand, should be continuous and the various processes systematically iterated, as this helps to ensure high product quality and adapt to dynamic changes.

This article would be helpful for researchers in the field of knowledge management and the NPI process, as well as for companies whose activities include New Product Introductions – especially if the process involves a complex team collaborating remotely. However, the limitations of the study should be mentioned. Research was conducted on a sample of 12 employees from Polish companies, so the results may not reflect the entire NPI area. In particular, it is advisable to carry out research that will take into account the division into different areas of companies' activities, as the described assessments by representatives of different industries differed from each other. It would also be advisable to analyze other processes of knowledge management, such as knowledge protection, as this study focused only on the processes most frequently discussed in the existing literature on the subject; however, given the dynamics of change in recent years and the increasingly rapid development of areas related to innovation, it is possible that processes that were of marginal importance before (and therefore not addressed in this analysis) are becoming more important over time and worthy of more detailed examination.

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## LEADERSHIP CHALLENGES DURING AND AFTER THE COVID-19 PANDEMIC IN A CONSUMER GOODS MARKET

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**Purpose:** The article aims to identify leadership challenges within the consumer goods market during the exceptional circumstances of COVID-19 and focus on the experiences of Philips company management.

**Design/methodology/approach:** The methods used in the research are participant observation, managerial point of view, and the descriptive/illustrative and retrospective case study, which offered an understanding of how leadership functions in response to disruptive conditions.

**Findings:** The analysed company faced supply chain disruptions, manufacturing adjustments, operational logistics issues, and demand fluctuations. There were implemented safety protocols, adjusted people management practices for remote work, prioritised health and safety, and focused on the mental well-being of employees. Philips continued to optimise the supply chain, enhance e-commerce capabilities, implement AI, and focus on sustainability and refurbishment.

**Research limitations/implications:** The findings are based on a case study, limiting the generalizability of results to other companies, even in the consumer goods market. The participant observation method introduces subjectivity, as the Author actively participated in managerial activities at Philips. Future research should explore leadership challenges across various industries, enabling a broader understanding of how different sectors navigated disruptions.

**Practical implications:** Leaders should prioritise building agile and resilient organisations. The ability to adapt quickly to unexpected challenges. This involves developing contingency plans, flexible work arrangements, and supply chain strategies that can withstand disruptions. Companies should prioritize the well-being of their employees. This involves implementing measures such as mental health support, flexible work arrangements, and clear communication about safety guidelines. Investing in employee training and development, especially digital skills, for adapting to the evolving work landscape.

**Originality/value:** A comprehensive overview of the challenges businesses face before, during, and after the COVID-19 pandemic and offering insights into the leadership employed by Philips in navigating disruptions. Highlighting industry-specific challenges and the importance of market leadership.

**Keywords:** leadership, COVID-19, consumer goods market.

**Category of the paper:** case study.

## Introduction

The business landscape before COVID-19 was relatively stable and predictable. International corporates were operating smoothly with a steady stream of revenue. They faced challenges such as increased global competition, adapting to new technologies, and customers demanding more personalised offers and convenient experiences. Other key business challenges before COVID-19 included talent shortage in finding and retaining qualified employees, especially vital for the technology and healthcare industries, and another problem was cybersecurity - threats from cyberattacks due to the sophistication of hackers and the growing number of connected devices (World Economic Outlook..., 2018; OECD Economic..., 2018).

COVID-19 exacerbated all of these challenges. The sudden outbreak of COVID-19 has significantly impacted businesses worldwide (Prospering in the pandemic..., 2020). Many companies had to shut down, while others had to switch to remote work to keep their employees safe (Evaluating the initial impact of COVID-19..., 2020).

During the COVID-19 pandemic, businesses had to adapt quickly to the new conditions. The shift towards digitalisation has become more prevalent than ever before (World Development Report..., 2022). Companies had to adopt new technologies and strategies to keep their operations running smoothly. Remote work became the norm, and virtual meetings replaced in-person ones (Kropp et al., 2021). The pandemic made it more difficult for businesses to operate globally and to find and retain qualified employees. COVID-19 also created new challenges for companies, such as:

- supply chain disruptions: the pandemic disrupted the global supply chain, making it difficult for businesses to get the materials and products they need (Harapko, 2023),
- changing consumer behaviour: the pandemic caused a shift in consumer behaviour, as people became more cautious about spending and switched to online shopping (Patil, Patil, 2020; Ahmed, 2021),
- remote work: businesses had to quickly adapt to remote work, which posed new challenges for communication, collaboration, and productivity (Galanti, et al., 2021).

Despite these challenges, many businesses have found ways to adapt and thrive during and after the pandemic. They have learned to be more agile, resilient, and customer-centric, embracing new technologies and business models (Bailey, Breslin, 2021). Nowadays, managers face the following challenges:

- climate change: a critical threat to businesses regarding physical damage and regulatory compliance. Companies need to develop strategies to adapt to and mitigate the risks of climate change,
- geopolitical tensions: the world is becoming more divided, with rising tensions between major powers (i.e. US vs. China; the Ukraine Russia War) – critical uncertainty for businesses that operate globally,
- AI as an opportunity (improve efficiency, productivity, and profitability) and a threat - risks such as job displacement, security, and ethics.

Furthermore, there are still some problems that existed before and during COVID-19 in similar areas, but with different nuances:

- economic uncertainty: rising inflation, supply chain disruptions, fluctuations in the mineral resources market and currency values,
- cybersecurity: becoming increasingly sophisticated and costly. Businesses must invest in robust cybersecurity measures to protect data and systems,
- talent shortage: to find and retain qualified employees (universal basic income idea, generations' Z and Alfa job appreciated needs and values).

The world is gradually recovering from the pandemic, and the business landscape is slowly returning to the “new” normal. However, the pandemic has brought about permanent changes in how companies work. Remote work will likely continue, and the shift towards digitalisation will continue accelerating. So, leadership capabilities seem more critical than regular management skills during disruption. While leadership and management are essential for an organisation's success, leadership plays a more critical role when navigating through disruptive periods (Bartram, Inceoglu, 2011).

A compelling vision and a well-defined strategy become paramount during disruption, uncertainty, and change. Leaders can inspire and motivate teams by articulating a vision that gives purpose and meaning to their work. This helps the organisation adapt to and thrive in disruptive conditions. Disruption often requires rapid adaptation to new circumstances. Leadership involves being agile, flexible, and innovative in response to unexpected challenges. Leaders can make quick decisions and encourage a culture of experimentation and learning, which is crucial during disruptive times (Nawaz, Khan, 2016).

The primary objective of this article is to elucidate the multifaceted leadership challenges encountered by organisations operating in the consumer goods market amid and post the COVID-19 pandemic. Using Philips as a case study, the article aims to scrutinise specific activities undertaken by the company during the pandemic to navigate unprecedented disruptions and sustain operational resilience. The analysis presents aspects of leadership employed by Philips, shedding light on the decision-making processes, adaptive market approach, and strategic initiatives that delineate the company's response to the unique challenges posed by the global health crisis. Through examining Philips' experiences,

this article seeks to contribute valuable insights to the scholarly discourse on effective leadership in the face of exceptional circumstances within the consumer goods sector.

In elucidating the intricate dynamics of leadership challenges within the consumer goods market during and after the COVID-19 pandemic, this article employs a methodological dyad comprising participant observation, managerial point of view, and the descriptive/illustrative and retrospective case study method. The participant observation method (Iacono et al., 2009, Bonner, Tolhurst, 2002) gives immersion in the organisational milieu, closely observing and, in this case, participating in the day-to-day activities and decision-making processes of leaders within Philips. By actively participating in managerial activities, the Author gained firsthand insights into the nuances of leadership strategies adopted by Philips during the pandemic. Furthermore, the descriptive/illustrative case study method (Thomas, 2011) is applied to provide a rich narrative account of specific activities undertaken by the company, offering a detailed and contextually grounded exploration of Philips' responses to the unprecedented challenges posed by the global health crisis. Additionally, the retrospective case study method is employed to analyse and interpret the outcomes of managerial decisions, affording a comprehensive understanding of the long-term implications of the strategies. Through the synthesis of these methodological approaches, this article aims to provide a nuanced and comprehensive analysis of leadership challenges in the consumer goods market, leveraging Philips as a pertinent case study.

## **Leadership in environment conditions disruptions**

Leaders have the ability to inspire and engage employees, fostering a sense of commitment and resilience. Communication skills can provide hope and confidence, even in the face of uncertainty. This is particularly important during disruptions, as motivated and engaged employees are more likely to overcome obstacles and find creative solutions (El Namaki, 2017).

During disruptions, leaders must be willing to take calculated risks to explore new opportunities or approaches. Regular management, focused on day-to-day operations, may be risk-averse, hindering adaptation during disruptive periods (Matarazzo, Pearlstein, 2016).

Leadership typically emphasises long-term, strategic thinking. Leaders consider the broader context and implications of actions, which is crucial during disruptions when short-term fixes may not be sufficient. Management, on the other hand, often focuses on short-term operational tasks. Leadership skills are essential for crisis management. Effective leadership is critical when disruptions escalate into full-blown crises, as regular management practices may not suffice (Wooten, James, 2008; Surugiu, Surugiu, 2012; Harwati, 2013). Leadership encourages innovation and the pursuit of new opportunities. Disruptions can create opportunities for those



who are willing to innovate and seize them. Leadership is essential for fostering an innovative culture within an organization (Bhaduri, 2019).

While regular management is essential for day-to-day operations and maintaining stability, leadership is more critical during disruptive times because it provides the vision, adaptability, inspiration, and strategic thinking needed to navigate and thrive in uncertain and rapidly changing circumstances. Leadership propels an organization forward and enables it to turn disruptions into opportunities for growth and transformation.

Leadership challenges nowadays are numerous and complex. Leaders are facing a rapidly changing world with increasing uncertainty and disruption. They are also under pressure to deliver results more ethically and sustainably. Some of the critical leadership challenges nowadays include (Kouzes, Posner, 2023; Padhy et al., 2022; Krause, Balasescu, 2022; Kuratko, 2017; Li et al., 2022; Olcott et al., 2023):

- leading change: leaders need to be able to lead their teams through change effectively which can be unsettling and disruptive for staff,
- building trust: with teams, stakeholders, and customers with honesty, transparency, and accountability,
- developing people: requires providing training and development opportunities, as well as creating a positive and supportive work environment,
- culture of innovation: businesses need to be innovative in order to succeed, where team members feel comfortable taking risks and trying new things,
- promoting diversity and inclusion: creating a workplace where everyone feels welcome and respected,
- new generations in the labour market (Gen Z, Alfa): different expectations and real company realities (the issue with living in a different bubble),
- remote work and hybrid models: team spirit creation and staff relationship building by working online (lack of onsite office hours and socialization), managing remote teams, maintaining productivity, and ensuring employee well-being,
- talent retention: to focus on talent retention strategies to keep their best employees from seeking opportunities elsewhere,
- mental health and well-being: support teams' mental health and provide resources for coping with stress and burnout,
- technology, automation and AI: making strategic decisions about how to leverage technologies while considering their impact on the workforce,
- health and safety: ensuring the health and safety of employees, customers, and stakeholders is a critical responsibility for leaders, especially in the context of the ongoing pandemic,
- communication challenges: communicate vision, values, and strategies clearly and consistently to inspire and engage teams.

In addition to these general challenges, leaders have to face specific challenges depending on their industry and location.

Leadership capabilities are essential for achieving corporate market leadership (Useem, 1998). As the most influential, dominant, and often significant player in that particular market, they typically have a substantial market share, strong brand recognition, and the ability to set industry trends and standards, being at the forefront of innovation and considered the benchmark for others to follow. Achieving market leadership is a strategic goal for many companies, often leading to increased profitability and a competitive advantage. Market leaders play a critical role as trailblazers and stabilisers during disruptive times. They set the tone, lead by example, and provide a reference point for others in the industry. Their actions and decisions can have a profound impact on the collective response of companies within the market, helping to shape the industry's future and ensuring its resilience in the face of disruption.

### **Philips's leadership in the consumer goods market - before and after Covid-19**

Philips Group is a global company in health technology, operating in multiple sectors such as healthcare or personal health consumer goods. With a history of over 130 years, Philips has established a significant global presence. Philips operates 23 production facilities worldwide to meet the needs of different markets efficiently. These production sites are strategically located across various regions, such as the Netherlands, United States, China, India, and Brazil, allowing the company to optimise its supply chain and ensure timely product delivery. With its diverse portfolio of innovative products and solutions, Philips has a strong commercial presence in numerous countries and is a leader worldwide. The company operates through a network of sales and distribution channels, including partnerships with retailers, online platforms, and healthcare institutions. This wide commercial presence enables Philips to reach a broad customer base and cater to their needs effectively. Philips Group comprises two main divisions – strategic business units: B2B/B2G (Diagnosis & Treatment, Connected Care) and B2C (Personal Health). The importance of each of them to Philips is provided in Table 1.

**Table 1.**  
*Philips Group B2B/B2G and B2C total sales*

Segments	2022
Diagnosis & Treatment	51%
Connected Care	25%
Personal Health	20%
Other	4%

Source: Internal Philips Group data, Annual Report 2022, <https://www.results.philips.com/downloadcenter>, 15.09.2023.

Hence, apart from the overarching approach of Philips Group to the COVID-19 outbreak, one can find some significant differences concerning internal and external stakeholders. Since Philips offers many devices and solutions critical in such a pandemic as COVID-19, e.g. respiratory equipment, ventilators, acute care systems, etc., its B2B and B2C parts' posture differed. When it comes to B2B division focus was placed on:

- collaboration with governments and healthcare institutions, delivering critical equipment and expertise. For example, in addressing the needs for critical equipment, Philips doubled the production of hospital ventilators,
- support the well-being of healthcare professionals and employees by offering training programs, informational resources, and online platforms for collaboration and knowledge sharing.

Whereas for B2C enterprise:

- focus on direct interaction and engagement with consumers, understanding changing consumer behaviours, and addressing their needs in a rapidly evolving environment,
- leverage various channels, such as social media, online campaigns, and customer support, to address concerns, share updates on safety measures, and offer reassurance,
- enhance digital platforms, strengthening e-commerce capabilities and online customer experiences to ensure seamless customer journey.

The COVID-19 pandemic has introduced new market conditions for Philips Group. What had worked as a well-functioning system in pre-pandemic times during the COVID-19 outbreak faced several challenges:

1. Supply chain disruptions: the pandemic led to disruptions in global supply chains, affecting the availability of essential components and materials. Travel restrictions, lockdown measures, and shifts in demand patterns created obstacles in sourcing, manufacturing, and distributing products. Philips had to adapt quickly to mitigate these disruptions and ensure the continued flow of goods across their global production footprint.
2. Manufacturing and production adjustments: to comply with health and safety regulations and protect the well-being of employees, Philips had to implement new protocols within their production facilities. These protocols included social distancing measures, enhanced sanitation practices, and shift adjustments. Adapting manufacturing processes to meet these requirements without compromising efficiency and product quality posed significant challenges.
3. Operational logistics: the pandemic introduced logistical challenges due to limited transportation options, border restrictions, and changing regulations. Overcoming disruptions in transportation networks and maintaining smooth distribution channels was crucial in meeting the increased demand for essential healthcare products.

4. Remote work and collaboration: the global lockdown measures forced many employees to work remotely. This shift required Philips to swiftly implement remote collaboration tools and communication platforms to ensure seamless coordination among team members, suppliers, and partners across different regions. Adapting to remote work practices while maintaining productivity and effective collaboration posed additional challenges.
5. Demand fluctuations: the COVID-19 outbreak led to unpredictable shifts in demand for different product categories. Philips had to respond to emerging healthcare needs and prioritize the production of critical medical equipment such as ventilators and diagnostic devices. This required agile production planning and realigning resources to meet the urgent requirements arising from the pandemic.

Internally, towards its employees, Philips introduced the following solutions:

1. Three layers of Philips offices safety protocols: high, medium, low risk, assuming different levels of office/remote work ratio, office occupancy, field force management, etc.
2. People management practices have been adjusted to support remote work, including providing necessary technology, ensuring clear communication channels, and assessing performance remotely. Flexible work arrangements have also become more familiar to accommodate employees' situations.
3. Prioritize the health and safety of their employees, implementing measures such as increased sanitation practices, providing personal protective equipment, and enforcing social distancing protocols in workplaces that require physical presence. People management has included regular communication about safety guidelines, monitoring employee health, and providing necessary support.
4. Focus on supporting employees' mental health and well-being by providing resources for stress management, promoting work-life balance, and encouraging regular check-ins with managers to address any challenges or concerns.
5. Prioritize virtual communication and collaboration tools. Philips has utilized to full extend video conferencing platforms (Microsoft Teams), project management software, reduce to absolute minimum in-person meetings or trainings to facilitate regular communication, team meetings, and collaboration among employees. Invest in employee training and development, such as digital skills, virtual teamwork, and adaptability. Providing online training programs, webinars, and resources to upskill employees and ensure they remain effective in their roles.
6. Maintaining employee engagement and motivation has become a priority. Regular communication keeps employees connected, motivated, and aligned with company goals.

7. Embrace agility and adaptability in the face of uncertainty, open to change as the business landscape continues to evolve rapidly. This includes adjusting goals and priorities, reorganising teams, and responding to changing customer needs.

In 2023, when COVID-19 is no longer treated as a pandemic, particular solutions and changes implemented will be continued and practised, but in a different format, and some will finally be abandoned. Solution and practices which will be continued as still critical in the process of management:

- optimising the supply chain to serve customers' needs better. Consumers also expect a wider range of payment methods, shorter delivery times, different payment architectures (e.g. subscription models), etc. On the one hand, that shift requires additional investments from companies (e.g. in workforce and technology); on the other hand, it comes with an extra turnover or margin and loyalise users;
- focus on e-commerce, digitalization. With social distancing measures and lockdowns in place, people turned to online shopping for their basic needs and non-essential purchases. This led to a surge in e-commerce, with consumers relying heavily on online platforms for their shopping requirements. Concerns about person-to-person contact and the spread of the virus prompted a shift towards contactless delivery methods. More consumers now prefer doorstep deliveries and contactless payment options, which have become the norm in the e-commerce industry. This trend will continue with new, younger generations entering commerce with different habits and expectations;
- AI implementation – *There will be two kinds of companies at the end of this decade: those that are fully utilising AI, and those that are out of business* (Diamandis, 2022). Businesses can obtain valuable information about consumer actions and inclinations through AI-driven data analytics and processing. This enables them to customise their products and marketing approaches to align with these insights. Furthermore, AI-powered automation and predictive modelling enhance inventory control, supply chain logistics, and predictive forecasting, increasing operational efficiency, cost reduction, and heightened customer contentment,
- sustainability & refurbishment – more than 50% of consumers claim that it is more important to reduce their carbon footprint since COVID-19 (How the COVID-19..., 2021). Companies naturally need to respond to this notion, committing and developing adequate solutions. Philips committed to generating 25% of its revenue till 2025 from circular products, services and solutions (Sustainability Commitments..., 2021). Recently, in consumer goods, Philips started to resell refurbished products, which raised very positive sentiments among the audience.

Leadership changes and improvements, which still are vital for sustaining Philips's market position, so they stay but in a different format:

- remote work – many companies implemented fully remote work during COVID-19, especially in its early stages. That was utterly understood due to pandemic measures but also highly appreciated as a permanent solution by many employees. However, many employers have noticed a drop in remote work efficiency challenges in running long meetings with many participants. As a result, some companies decided either to ask employees to return to the office or implement a hybrid protocol, e.g. three days in the office and two days at home. Most probably, it will evolve further together with the increase of AI involvement in many territories and the shifting nature of various positions (e.g. medical services could be proceeded outside hospitals in mini-clinics or at home, and this will tremendously change the role of the doctor);
- more hybrid 3+2 model, in-person attendance during longer or many-attendee meetings, challenges with talent acquisition (some people require fully remote work).

After COVID-19, some approaches and Philips business decisions have been abandoned or shifted. Philips returned to emphasise long-term planning over short-term fire-fighting. Many companies had to shift their focus to short-term planning in order to navigate the immediate challenges and uncertainties. However, as the situation stabilised and businesses began to adapt to the new normal, there has been a gradual transition back to long-term planning. The shift from short-term to long-term planning involves reevaluating business strategies, setting new goals, and devising sustainable plans for the future. The pandemic served as a factor for resilience and adaptability. Companies have realised the need to anticipate potential disruptions and build resilience into their business models. Long-term planning allows organisations to anticipate and prepare for challenges while exploring new growth opportunities.

## Conclusions

The article explores the multifaceted leadership challenges faced by consumer goods market organizations during and after the COVID-19 pandemic, with a specific focus on Philips' experiences. The global health crisis intensified existing business challenges, such as supply chain disruptions, changes in consumer behaviour, and the rapid shift to remote work. Despite these challenges, Philips, as a market leader, demonstrated resilience and adaptability through strategic leadership actions.

The study emphasises that leadership capabilities have become even more critical than regular management skills during disruptions. The ability of leaders to articulate a compelling vision, make quick decisions, and foster a culture of innovation and adaptability plays a pivotal

role in navigating through uncertainties. Leadership, instead of management, focuses on long-term, strategic thinking, which is essential during disruptive periods.

The methodologies employed in the study, including participant observation, managerial perspective, and case study analysis, provide a comprehensive understanding of the leadership dynamics within the consumer goods market. The case study of Philips serves as a valuable illustration of the decision-making processes, adaptive market approaches, and strategic initiatives undertaken by the company to ensure operational resilience during the pandemic.

The leadership challenges discussed extend beyond the immediate impact of COVID-19, addressing ongoing and emerging issues. The complexities faced by leaders encompass climate change concerns, geopolitical tensions, the opportunities and threats posed by AI, economic uncertainties, and persistent issues like cybersecurity and talent shortage. Moreover, leaders are confronted with the imperative to navigate evolving workplace dynamics, including the continuation of remote work, diversity and inclusion initiatives, and addressing mental health and well-being concerns.

The article identifies the critical role of market leaders like Philips in setting industry standards, guiding others through disruptive times, and shaping the future of their respective sectors. The challenges faced by Philips during the pandemic, particularly in supply chain management, manufacturing adjustments, and demand fluctuations, underscore the importance of proactive leadership in ensuring business continuity.

The study suggests that businesses, including Philips, are likely to continue focusing on optimising supply chains, embracing e-commerce, and implementing AI technologies for enhanced efficiency and customer satisfaction. Sustainability and refurbishment initiatives and a commitment to circular products reflect an acknowledgement of changing consumer preferences and a dedication to corporate responsibility.

Leadership improvements, such as the evolution of remote work models and the emphasis on hybrid work arrangements, are highlighted as ongoing strategies for sustained market position. The shift from short-term to long-term planning is identified as a critical outcome of the pandemic, signalling that businesses recognise the need for resilience and adaptability in the face of future disruptions.

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## BUSINESS ANALYTICS IN THE CASE OF PROCESS OPTIMALIZATION IN INDUSTRY 4.0 CONDITIONS

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**Purpose:** The purpose of this publication is to present the applications of usage of business analytics in process optimization.

**Design/methodology/approach:** Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

**Findings:** In the era of Industry 4.0, the intersection of data-driven technologies and manufacturing processes underscores the indispensable role of business analytics in process optimization. This transformative landscape redefines business operations, highlighting data analytics as the cornerstone of operational excellence. Business analytics offers a multitude of advantages, including data-driven decision-making, efficiency enhancements, predictive capabilities, and cost reduction, ultimately ensuring a competitive edge. Nevertheless, it also presents a set of challenges, such as data quality, integration, and resistance to change. Overcoming these obstacles is essential to fully unlock the potential of business analytics in Industry 4.0. In doing so, organizations can navigate this dynamic landscape and secure their position in the ever-evolving industrial ecosystem.

**Keywords:** business analytics, Industry 4.0, digitalization, artificial intelligence, real-time monitoring; process optimization.

**Category of the paper:** literature review.

### 1. Introduction

In today's rapidly evolving industrial landscape, the convergence of data-driven technologies and manufacturing processes has given rise to what is commonly known as Industry 4.0 (Wolniak, 2016; Czerwińska-Lubszczyk et al., 2022; Drozd, Wolniak, 2021; Gajdzik, Wolniak, 2021, 2022; Gębczyńska, Wolniak, 2018, 2023; Grabowska et al., 2019, 2020, 2021; Wolniak et al., 2023; Wolniak, Grebski, 2023; Wolniak, Skotnicka-Zasadzień, 2023; Jonek-Kowalska, Wolniak, 2023). This transformative shift has redefined how businesses

operate and has created an environment where data analytics plays a pivotal role in optimizing processes and enhancing productivity. Among the many applications of data analytics in this context, process optimization stands out as a critical aspect of achieving operational excellence.

Industry 4.0, characterized by the integration of the Internet of Things (IoT), artificial intelligence, machine learning, and automation, has led to an unprecedented influx of data within industrial settings. This data includes real-time sensor readings, production logs, supply chain information, and customer feedback. Leveraging this wealth of data through business analytics is instrumental in fine-tuning operations for efficiency and competitiveness (Ghibakholl et al., 2022).

Business analytics has become a cornerstone of process optimization in Industry 4.0 conditions. By harnessing the power of data, companies can drive efficiency, quality, and innovation in their operations, ultimately ensuring their competitiveness in an increasingly digitized and interconnected industrial landscape. Those who embrace these analytical tools and methodologies are better positioned to thrive in this new era of manufacturing and commerce.

The purpose of this publication is to present the applications of usage of business analytics in process optimization.

## **2. The selected aspects of business analytics usage in process optimization**

The first step in any analytics-driven process optimization initiative is to gather relevant data from various sources, such as sensors, machines, and enterprise software systems. This data is then integrated into a centralized platform for analysis, ensuring that it is both accessible and structured for meaningful insights. Industry 4.0 environments thrive on real-time decision-making. With the help of analytics, businesses can monitor processes as they happen, enabling quick responses to deviations, anomalies, and bottlenecks. Real-time insights are particularly crucial for industries like manufacturing, where even small delays can have significant consequences (Bakir, Dahlan, 2022).

One of the most valuable applications of analytics is in predicting equipment failures before they occur. By analyzing historical data and sensor readings, predictive maintenance can be implemented, reducing downtime and increasing the lifespan of machinery. Analytics identifies areas of inefficiency in production and supply chain processes. By analyzing historical and real-time data, businesses can optimize workflows, reduce waste, and minimize energy consumption. In Industry 4.0, maintaining high-quality standards is critical. Analytics can be used to continuously monitor product quality, detect defects, and provide immediate feedback to production lines, ensuring that only high-quality products reach the market (Wolniak,

Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022).

Through data analysis, companies can better manage their inventories by predicting demand and optimizing stocking levels. This leads to cost savings and a more responsive supply chain. Analytics enables businesses to pinpoint areas of unnecessary expenditure and optimize resource allocation. By reducing operational costs, companies can improve their bottom line.

In Industry 4.0, mass customization is a reality. Analytics helps companies understand customer preferences and tailor products and services accordingly, increasing customer satisfaction and loyalty. With the increasing emphasis on sustainability, analytics can help industries minimize their environmental footprint by optimizing processes to reduce waste, energy consumption, and emissions. Business analytics in Industry 4.0 facilitates a culture of continuous improvement. By regularly analyzing data and performance metrics, companies can adapt to changing market conditions and stay ahead of the competition (Olsen, 2023).

Table 1 contains descriptions of how business analytics is used in process optimization. This table provides a concise overview of the various ways business analytics is employed for process optimization in Industry 4.0 conditions. Each application serves to enhance efficiency, quality, and sustainability while promoting a culture of continuous improvement in industrial operations (Jonek-Kowalska, Wolniak, 2021, 2022; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021; Orzeł, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021).

Business analytics empowers organizations to make informed decisions based on data rather than intuition. Through the collection and analysis of data from various sources, including IoT sensors, production logs, and supply chain records, companies gain a deeper understanding of their operations. Industry 4.0 emphasizes real-time operations. Analytics tools provide the capability to monitor processes as they occur, allowing for immediate detection of issues, performance deviations, and bottlenecks. This real-time visibility enables swift responses and adjustments (Nourani, 2021).

By leveraging historical data and machine learning algorithms, predictive maintenance models can forecast equipment failures before they happen. This proactive approach reduces downtime and extends the life of critical machinery. Analytics helps identify inefficiencies in production and supply chain processes. It provides the means to continuously analyze historical and real-time data to pinpoint areas for improvement (Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Wolniak, 2011, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Gajdzik, Wolniak, 2023; Wolniak, 2013, 2016; Hys, Wolniak, 2018). Optimization efforts can lead to increased efficiency, reduced waste, and energy savings. Maintaining product quality is paramount. Business analytics is instrumental in continuously monitoring quality parameters and quickly identifying defects or deviations from quality standards. This ensures that only high-quality products reach the market (Greasley, 2019).

Analytics tools help in managing inventory more efficiently. They forecast demand patterns, enabling organizations to optimize stock levels and reduce carrying costs while ensuring product availability. Businesses can identify and eliminate unnecessary expenses through data analysis. By optimizing resource allocation and reducing operational costs, they can enhance profitability and competitiveness.

**Table 1.**  
*The usage of business analytics in process optimization*

Aspect of process optimization	Description
Data Collection and Integration	Gather data from various sources, such as sensors, machines, and enterprise software systems, and integrate it for analysis.
Real-Time Monitoring	Monitor processes in real time, allowing for quick responses to deviations, anomalies, and bottlenecks.
Predictive Maintenance	Predict equipment failures using historical data and sensor readings, reducing downtime and extending machinery lifespan.
Process Optimization	Analyze historical and real-time data to identify inefficiencies, optimize workflows, reduce waste, and minimize energy consumption.
Quality Control	Continuously monitor product quality, detect defects, and provide immediate feedback to production lines.
Inventory Management	Predict demand and optimize stocking levels for efficient inventory management, reducing costs and improving the supply chain.
Cost Reduction	Identify areas of unnecessary expenditure and optimize resource allocation to reduce operational costs.
Customization and Personalization	Use analytics to understand customer preferences and tailor products and services, increasing customer satisfaction and loyalty.
Sustainability	Optimize processes to reduce waste, energy consumption, and emissions, contributing to sustainability goals.
Continuous Improvement	Establish a culture of continuous improvement by regularly analyzing data and performance metrics, adapting to changing market conditions.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

### 3. Software used in process optimization in Industry 4.0 conditions

Inventory management is a vital aspect of business operations, and numerous software and applications have been developed to streamline and optimize this crucial function. These solutions offer a wide range of features and capabilities to meet the diverse needs of businesses, whether they are large enterprises or small and mid-sized companies (Aslam et al., 2020).

SAP's inventory management software is an integral part of its ERP suite. It provides comprehensive tools for tracking and optimizing inventory. Key features include real-time visibility, demand forecasting, and replenishment planning. Oracle's inventory management solution is designed to work seamlessly with its suite of business software. It offers features such as multi-location support, lot and serial tracking, and cycle counting.

Microsoft's cloud-based Dynamics 365 offers end-to-end inventory and supply chain management. It provides real-time visibility, supports demand forecasting, and allows for vendor collaboration. QuickBooks Commerce is a cloud-based platform suitable for small to mid-sized businesses. It offers multi-channel sales, order management, and robust reporting and analytics (Scappini, 2016).

Fishbowl Inventory is a popular QuickBooks add-on that enhances inventory control. It features capabilities like barcoding, multi-location support, and order management. Zoho Inventory is a cloud-based solution tailored for small businesses. It offers tools for order management, multi-channel sales, and batch tracking.

TradeGecko is designed for e-commerce businesses, providing inventory and order management solutions. Key features include sales and purchase order management, demand forecasting, and a B2B e-commerce portal. inFlow Inventory is designed for small businesses and offers customization options. It supports barcoding, provides detailed reporting, and manages sales and purchase orders (Javaid, Haleem, 2020).

Odoo Inventory is part of the open-source Odoo ERP suite. It offers real-time inventory updates, batch and serial tracking, and robust warehouse management features. Wasp Inventory Control is a software solution ideal for small and medium-sized businesses. It supports barcoding, automated alerts, and provides reporting and analytics capabilities (Charles et al., 2023).

Table 2 highlighting examples of software and applications used in inventory management, along with descriptions of their usage. These software and applications offer a range of features and functionalities to cater to the diverse needs of businesses when it comes to inventory management. Depending on the size of the business, the complexity of operations, and specific requirements, organizations can select the most suitable solution to efficiently manage their inventory and streamline supply chain operations.

**Table 2.**

*The usage of business analytics software in process optimization*

Software/Application	Description	Key Features
<b>SAP Inventory Management</b>	Part of the SAP ERP suite, it offers comprehensive inventory tracking and optimization.	Real-time visibility, demand forecasting, replenishment planning.
<b>Oracle Inventory</b>	Integrated with Oracle's broader suite of business software for end-to-end inventory control.	Multi-location support, lot and serial tracking, cycle counting.
<b>Microsoft Dynamics 365</b>	A cloud-based solution for inventory and supply chain management.	Real-time visibility, demand forecasting, vendor collaboration.
<b>QuickBooks Commerce</b>	A cloud-based inventory and order management platform for small to mid-sized businesses.	Multi-channel sales, order management, reporting, and analytics.
<b>Fishbowl Inventory</b>	A popular QuickBooks inventory add-on for enhanced inventory control.	Barcoding, multi-location support, order management.
<b>Zoho Inventory</b>	A cloud-based inventory management solution for small businesses.	Order management, multi-channel sales, batch tracking.

Cont. table 2.

<b>TradeGecko</b>	Inventory and order management software designed for e-commerce businesses.	Sales and purchase order management, demand forecasting, B2B e-commerce portal.
<b>inFlow Inventory</b>	A small business-focused inventory software with various customization options.	Barcode support, reporting, sales and purchase orders.
<b>Odoo Inventory</b>	Part of the open-source Odoo ERP suite, it provides a wide range of inventory management tools.	Real-time inventory updates, batch and serial tracking, warehouse management.
<b>Wasp Inventory Control</b>	A software solution offering asset and inventory tracking for small and medium-sized businesses.	Barcode support, automated alerts, reporting, and analytics.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

#### 4. Advantages and problems of business analytics usage in process optimization

Business analytics empowers organizations to make informed decisions based on concrete data and insights. It reduces the reliance on gut feelings or intuition, leading to more accurate and strategic choices. Analytics scrutinizes processes, uncovering inefficiencies, redundant tasks, and bottlenecks. By addressing these issues, organizations can optimize their operations, resulting in increased productivity and substantial cost savings (Peter et al., 2023).

Business analytics enables organizations to forecast future trends, demands, and potential issues. This forecasting capability allows businesses to plan proactively, mitigate risks, and seize opportunities before their competitors do. Through process optimization, analytics helps organizations contain costs. It identifies areas where resources are misallocated or overallocated, effectively reducing waste and minimizing operational expenses (Cillo et al., 2022).

Business analytics provides insights into the optimal allocation of resources, including manpower, time, and equipment. This leads to improved resource utilization, reduced underutilization, and ultimately greater efficiency. Leveraging analytics for process optimization enables companies to respond swiftly to market changes and evolving customer preferences. This agility provides a competitive edge, helping businesses stay ahead in their industries (Adel., 2022).

Table 3 contains the advantages of using business analytics in process optimization within Industry 4.0 conditions, along with descriptions for each advantage.



**Table 3.***The advantages of using business analytics in process optimization*

<b>Advantage</b>	<b>Description</b>
Data-Driven Decisions	Utilizing historical and real-time data, organizations can make well-informed decisions, reducing reliance on guesswork and intuition. This leads to more accurate and strategic choices.
Improved Efficiency	Business analytics identifies inefficiencies, redundant tasks, and bottlenecks within processes. By addressing these issues, organizations can optimize their operations, leading to increased productivity and cost savings.
Enhanced Predictive Capabilities	Analytics enables organizations to forecast future trends, demand, and potential issues. This forecasting ability empowers businesses to plan proactively, mitigate risks, and seize opportunities ahead of competitors.
Cost Reduction	Through process optimization, analytics helps in cost containment. It identifies areas where resources are overallocated or misallocated, thereby reducing waste and minimizing operational expenses.
Better Resource Allocation	Business analytics provides insights into resource allocation, ensuring that resources like manpower, time, and equipment are assigned optimally. This leads to improved resource utilization and reduced underutilization.
Competitive Advantage	Leveraging analytics for process optimization allows companies to respond quickly to market changes and evolving customer preferences. This agility provides a competitive edge, helping businesses stay ahead in their industries.
Improved Customer Experience	By analyzing data on customer behavior and feedback, organizations can refine their processes to better meet customer needs and expectations. This leads to higher customer satisfaction and loyalty, enhancing the overall experience.
Enhanced Risk Management	Business analytics helps in identifying potential risks and vulnerabilities within processes. By addressing these issues, organizations can minimize the impact of unexpected events and maintain operational stability.
Scalability and Growth	Process optimization using analytics ensures that operations are scalable. As businesses grow, they can adapt and expand their processes more efficiently, accommodating increased demand without significant disruptions.
Regulatory Compliance	Analytics can assist in monitoring and ensuring compliance with industry regulations and standards. This reduces the risk of non-compliance, penalties, and reputational damage, promoting a culture of accountability.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

The quality of the data used in analytics is paramount. Inaccurate, incomplete, or inconsistent data can lead to erroneous conclusions and misguided optimization efforts. Data cleansing and validation are necessary to ensure that the analytics process is built on a solid foundation. Many organizations store data in disparate systems and formats. Integrating this data into a unified dataset can be complex and time-consuming. Data integration challenges often require significant technical resources and expertise.

The shortage of qualified data analysts and data scientists can hinder optimization efforts. Skilled professionals are needed to operate analytics tools, interpret results, and effectively communicate insights to stakeholders. Recruitment and continuous training are essential to address this problem. Acquiring and implementing analytics tools, infrastructure, and training personnel can be costly. This financial burden can be a significant barrier for smaller businesses or organizations with limited budgets.

Employees may resist changes suggested by data-driven insights. This resistance can stem from concerns about job displacement, lack of trust in the technology, or the perceived threat to established processes. Convincing the workforce to embrace change is a significant challenge. Relying solely on historical data may lead to optimization strategies that are ill-suited for current conditions. The analytics process must account for evolving market dynamics and emerging trends to remain relevant and effective (Di Marino et al., 2023).

Table 4 contains the problems of using business analytics in process optimization within Industry 4.0 conditions, along with descriptions for each advantage.

**Table 4.**

*The problems of using business analytics in process optimization*

Problem	Description
<b>Data Quality Issues</b>	Inaccurate, incomplete, or inconsistent data can lead to faulty analysis and unreliable optimization recommendations. Data cleansing and quality assurance are essential to mitigate this problem.
<b>Data Integration Challenges</b>	The integration of data from diverse sources, which may use different formats and structures, can be arduous and time-consuming. This may require significant resources and specialized tools to achieve a unified dataset for analysis.
<b>Lack of Skilled Analysts</b>	A shortage of qualified data analysts and data scientists who can effectively utilize analytics tools, interpret results, and communicate insights can hamper optimization efforts. Continuous training and recruitment may be necessary.
<b>High Implementation Costs</b>	The cost of acquiring, implementing, and maintaining analytics tools, as well as the necessary infrastructure, can strain a company's budget. Additionally, ongoing licensing fees, hardware expenses, and personnel costs should be considered.
<b>Resistance to Change</b>	Employees may resist changes suggested by data-driven insights due to fear of job displacement, lack of trust in the technology, or concerns about the impact on established processes. This resistance can impede the implementation of optimization recommendations.
<b>Over-Reliance on Historical Data</b>	Relying solely on historical data may not account for changing market dynamics, emerging trends, and future uncertainties. An overreliance on past data can lead to optimization strategies that are outdated or ill-suited for current conditions.
<b>Lack of Clear Objectives</b>	Undefined or unclear optimization goals can result in unfocused analytics efforts, causing wasted resources and confusion among the team. Having a well-defined, strategic roadmap is essential for successful optimization.
<b>Privacy and Security Concerns</b>	Analyzing sensitive data can pose significant privacy and security risks. Ensuring compliance with data protection regulations, maintaining data encryption, and implementing strict access controls are imperative to address these concerns.
<b>Scalability Issues</b>	As the business grows, the analytics infrastructure may face challenges in terms of scalability. The system may not easily accommodate increased data volumes and complex analyses, resulting in performance bottlenecks and escalating costs.
<b>Misalignment with Business Strategy</b>	If the optimization goals do not align with the overall business strategy, it can lead to misguided efforts and suboptimal results. It's crucial to ensure that analytics initiatives are closely linked to the broader business objectives and priorities.
<b>Tool Selection and Vendor Lock-In</b>	Selecting the right analytics tools can be challenging, and businesses may inadvertently become locked into a particular vendor's ecosystem. This can limit flexibility, hinder innovation, and increase dependency on a single supplier.
<b>Lack of Real-Time Analytics</b>	Some optimization processes require real-time or near-real-time insights. If the analytics infrastructure cannot provide this, decision-makers may not be able to respond quickly to changing conditions or emerging opportunities.
<b>Difficulty in Measuring ROI</b>	Quantifying the return on investment (ROI) of business analytics for process optimization can be complex. Measuring the direct impact of analytics on profitability and efficiency may require sophisticated tracking and analysis.

Cont. table 4.

<b>Cultural and Organizational Challenges</b>	Transforming a company's culture to embrace data-driven decision-making can be challenging. Resistance to change, a lack of data-driven mindset, and siloed organizational structures can hinder the adoption of analytics for process optimization.
<b>Inadequate Data Governance</b>	Poor data governance practices can lead to data inconsistency, lack of data lineage, and data ownership issues. Effective data governance is crucial for maintaining data quality and integrity throughout the analytics process.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

## 5. Conclusion

In the dynamic realm of Industry 4.0, where data-driven technologies and manufacturing processes intersect, the role of business analytics in process optimization cannot be overstated. This transformative landscape has redefined the way businesses operate, emphasizing the pivotal role of data analytics in achieving operational excellence. From real-time monitoring to predictive maintenance, from quality control to sustainability, business analytics is the cornerstone upon which organizations build their path to success in this new era.

The advantages of leveraging business analytics are numerous. It empowers organizations to make data-driven decisions, leading to more accurate and strategic choices. Through efficiency improvements, predictive capabilities, cost reduction, and better resource allocation, businesses can enhance their operations and maintain a competitive edge. It also fosters improved customer experiences, better risk management, scalability, and regulatory compliance.

However, it's vital to recognize the challenges that come hand-in-hand with integrating business analytics into process optimization. Data quality issues, data integration challenges, and the scarcity of skilled analysts are common hurdles that need to be addressed. The high implementation costs, resistance to change, and over-reliance on historical data can pose significant roadblocks. Misalignment with business strategy, vendor lock-in, and a lack of real-time analytics also require careful consideration. Measuring ROI, tackling cultural and organizational challenges, and establishing effective data governance further add to the complexity.

In conclusion, the transformative potential of business analytics in process optimization within Industry 4.0 conditions is substantial. While it offers a multitude of benefits, it is not without its challenges. To harness the full potential of business analytics for process optimization, organizations must acknowledge and address these obstacles diligently. By doing so, they can unlock the power of data-driven decision-making and stay at the forefront of their respective industries, ultimately ensuring their competitiveness in a rapidly evolving and interconnected industrial landscape.

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## ENERGY EFFICIENCY MANAGEMENT IN SMART CITY – SMARTPHONE APPLICATIONS ASPECTS

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**Purpose:** The purpose of this publication is to present the usage of smartphone application in Smart Cities in energy efficiency management.

**Design/methodology/approach:** Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

**Findings:** The rise of the Internet of Things has made smart devices commonplace in homes and businesses. Smartphone apps play a key role in enabling users to control and monitor these devices, thereby enhancing energy efficiency. Real-time data on energy consumption informs users' decisions, leading to reduced energy waste and costs. These apps not only offer convenience but also support customization and automation for energy-efficient operations. Participation in demand response programs and integration with renewable energy sources further enhance energy efficiency. Smartphone applications also contribute to eco-friendly commuting and optimized waste management, while educating users about their environmental impact and ways to reduce energy consumption sustainably. Despite their advantages, smartphone applications face challenges related to data privacy, adoption, compatibility, user education, reliability, affordability, and access inequalities. Overcoming these challenges is crucial for smart city planners and developers to fully harness the potential of smartphone applications in creating energy-efficient and sustainable smart cities.

**Keywords:** Smart City, energy efficiency, energy efficiency management, smartphone applications, smart mobility.

**Category of the paper:** literature review.

### 1. Introduction

Energy efficiency management in smart cities, particularly in the context of smartphone applications, plays a pivotal role in creating sustainable, environmentally friendly urban environments. This article will delve into the various aspects of how smartphone applications are contributing to energy efficiency in smart cities.

Smartphone applications are integral to the success of energy efficiency management in smart cities. By providing users with real-time data, control over their surroundings, and information about sustainable practices, these apps empower individuals and organizations to contribute to the broader goal of creating greener and more energy-efficient urban spaces.

The purpose of this publication is to present the usage of smartphone application in Smart Cities in the case of energy efficiency management.

## **2. The usage of smartphone applications in energy efficiency management**

Smartphone applications enable users to remotely control and monitor various aspects of their homes and workplaces. This includes adjusting the thermostat, turning off lights, and managing appliances. This level of control helps in reducing energy consumption by ensuring that devices are not unnecessarily left running. These applications collect and analyze real-time data from sensors embedded in the infrastructure of smart cities. This data includes information on traffic flow, weather conditions, and energy usage patterns. By processing this data, the applications can suggest optimal routes for commuters, encourage carpooling, and even predict and manage energy demand more efficiently (Rachmawati et al., 2021; Dutta et al., 2021; Ivanyi, Biro-Szigeti, 2019).

With the advent of the Internet of Things (IoT), smart devices and appliances have become ubiquitous in modern homes and commercial buildings. Smartphone applications play a central role in enabling users to remotely control and monitor these devices. From adjusting the thermostat and controlling lighting to managing heating, ventilation, and air conditioning (HVAC) systems, these apps put the power of energy efficiency in the palm of your hand. Whether you're at home or halfway around the world, you can ensure that your spaces are using energy optimally (Wolniak, Sułkowski, 2015, 2016; Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022). One of the key advantages of remote control and monitoring is the access to real-time energy data. Smart meters and sensors collect detailed information about electricity, water, and gas usage. This data is then presented to users through intuitive smartphone apps, allowing them to track and visualize their energy consumption patterns. By having this data at their fingertips, individuals and organizations can make informed decisions about how to reduce energy wastage and cut down on costs. Many modern appliances are now "smart" and can be integrated with smartphone apps. Users can schedule the operation of appliances like washing machines, dishwashers, and ovens, so they run during off-peak energy hours or when electricity rates are lower. Moreover, users can remotely turn off or put appliances into an energy-saving mode when they are not in use (Herdiansayah, 2023; Rose et al., 2021).

Heating and cooling systems can be significant energy consumers. Smartphone apps enable users to remotely adjust the temperature, set schedules for HVAC operation, and even receive alerts when filters need replacement. These capabilities not only enhance comfort but also contribute to energy savings. Smart city applications also extend to security and surveillance systems. Users can monitor their homes or businesses through connected cameras and sensors, receiving real-time alerts and taking action remotely. This not only enhances safety but also reduces the energy footprint associated with maintaining a physical presence on-site. For users with renewable energy sources like solar panels, smartphone apps can display real-time data on energy generation and consumption. This allows homeowners to maximize their use of clean energy and minimize reliance on the grid (Rahman, Dura, 2022).

Smartphone applications allow users to remotely control lighting systems, including turning lights on and off or adjusting their brightness. This level of control is not only convenient but also promotes energy efficiency by ensuring that lights are only used when needed. For example, users can turn off lights in unoccupied rooms with a simple tap on their smartphones.

Many smartphone apps provide users with insights into their energy consumption. They can track and visualize how much energy is being used in different areas of their homes or workplaces. This awareness helps individuals and businesses make informed decisions about energy usage and, in turn, reduce their energy bills. Smartphone applications can connect with smart appliances and systems within buildings, allowing users to schedule tasks and create automation rules. For instance, lights can be programmed to turn off when a room is empty, and thermostats can adjust temperature settings based on the occupants' schedules (Jonek-Kowalska, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Wolniak, 2021, 2022; Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021).

Some smart city smartphone applications participate in demand response programs. These programs allow utilities to remotely manage energy consumption during peak periods. Users can opt into such programs and receive incentives for reducing their energy usage during high-demand times. Many smart cities are incorporating renewable energy sources like solar panels and wind turbines. Smartphone applications can provide users with information on the availability of renewable energy sources and even allow them to sell excess energy back to the grid, promoting a more sustainable energy ecosystem (Chmielarz et al., 2021).

Smartphone apps can help manage traffic flow, reducing congestion and thereby cutting down on fuel consumption. Real-time traffic updates and navigation services can guide drivers along the most efficient routes, helping to lower carbon emissions. Efficient waste collection and disposal contribute to energy efficiency. Smartphone apps can optimize waste management by scheduling collection services based on real-time data and encouraging recycling and composting practices (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień,

2008, 2010, 2014, 2018, 2019, 2022; Wolniak, 2011, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Gajdzik, Wolniak, 2023).

Many smart cities promote the use of public transportation and ride-sharing as eco-friendly alternatives to private car ownership. Smartphone apps for booking buses, trains, and rideshare services help users make more sustainable transportation choices. Smartphone applications also play a role in fostering behavioral change among citizens. They can educate users about the environmental impact of their actions and suggest ways to reduce energy consumption and live more sustainably (Simonofski et al., 2023; Chmielarz et al., 2021).

Table 1 contains descriptions of how smartphone applications are used in in energy efficiency management. It provides a concise overview of how smartphone applications are utilized in various aspects of energy efficiency management within smart cities.

**Table 1.**

*How smartphone applications are used in energy efficiency management*

Aspect of Energy Efficiency Management	Use of Smartphone Applications
Remote Control and Monitoring	Users can control home appliances, lighting, and HVAC systems remotely through smartphone apps, ensuring devices are not left running unnecessarily.
Real-time Data Analytics	Smartphone apps collect and analyze real-time data, such as traffic flow, weather conditions, and energy usage patterns, to optimize routes, encourage carpooling, and manage energy demand efficiently.
Energy Consumption Insights	Apps provide users with insights into their energy consumption, helping them track and visualize energy usage in different areas and make informed decisions to reduce energy consumption.
Smart Appliances Integration	Smartphone apps connect with smart appliances and systems, enabling users to schedule tasks and create automation rules for energy-efficient operation.
Demand Response Programs	Users can participate in demand response programs through apps, allowing utilities to manage energy consumption during peak periods, offering incentives for reducing usage.
Renewable Energy Integration	Apps provide information on the availability of renewable energy sources and enable users to sell excess energy back to the grid, promoting sustainability.
Traffic Management for Reduced Congestion	Apps offer real-time traffic updates and navigation services to guide drivers along efficient routes, reducing fuel consumption and carbon emissions.
Waste Management Optimization	Apps optimize waste collection by scheduling services based on real-time data, encouraging recycling and composting practices to reduce energy consumption.
Public Transportation and Ride-Sharing Services	Smartphone apps for booking public transportation and rideshare services promote eco-friendly alternatives to private car ownership.
Behavioral Change	Apps educate users about their environmental impact and suggest ways to reduce energy consumption and live more sustainably.

Source: (Kalasova et al., 2021; Chmielarz et al., 2021; Rose et al., 2021; Dutta et al., 2019; Ivani, Biro-Szigeti, 2019; Leal et al., 2023; Chowdhury et al., 2023; Sanchez et al., 2018; Aguilera, Boutueil, 2018).

Table 2 highlighting the advantages of using smartphone applications in energy efficiency management within smart cities. These advantages illustrate how smartphone applications are pivotal in energy efficiency management within smart cities, offering both convenience and sustainability benefits to individuals and communities alike.



**Table 2.***Advantages of using smartphone applications in energy efficiency management*

Advantage	Description
<b>Convenience and Accessibility</b>	Users can control and monitor energy-related devices and systems from anywhere, enhancing convenience and accessibility.
<b>Real-time Data Insights</b>	Apps provide real-time data on energy consumption, helping users make informed decisions to reduce usage and costs.
<b>Remote Control</b>	Remote management of appliances, lighting, and HVAC systems promotes energy efficiency by preventing unnecessary usage.
<b>Customization and Automation</b>	Users can schedule tasks and create automation rules to optimize energy usage based on their preferences and needs.
<b>Integration with Renewable Energy</b>	Smartphone apps can integrate with renewable energy sources, allowing users to monitor and maximize clean energy usage.
<b>Demand Response Participation</b>	Users can participate in demand response programs, earning incentives for reducing energy consumption during peak periods.
<b>Environmental Impact Awareness</b>	Apps educate users about their environmental impact, encouraging sustainable practices and reducing energy consumption.
<b>Traffic Management and Eco-friendly Commuting</b>	Smartphone apps assist in reducing congestion and promoting eco-friendly transportation choices, reducing fuel consumption.
<b>Waste Management Optimization</b>	Efficient waste collection and recycling are facilitated, contributing to energy efficiency and environmental sustainability.
<b>Security and Surveillance</b>	Users can enhance security and reduce energy usage by remotely monitoring and controlling surveillance systems through apps.
<b>Increased Comfort and Well-being</b>	Smartphone apps optimize heating and cooling, enhancing comfort and well-being while conserving energy.
<b>Grid Stability and Reliability</b>	By participating in demand response and monitoring energy usage, smartphone apps support grid stability and reliability.

Source: (Kalasova et al., 2021; Chmielarz et al., 2021; Rose et al., 2021; Dutta et al., 2019; Ivani, Biro-Szigeti, 2019; Leal et al., 2023; Chowdhury et al., 2023; Sanchez et al., 2018; Aguilera, Boutueil, 2018).

Smartphone applications make it incredibly convenient to control and monitor energy-related devices and systems. Users can adjust settings, receive real-time updates, and make informed decisions from anywhere, ensuring that energy management is at their fingertips. These apps provide users with valuable real-time data on their energy consumption. This information empowers individuals and organizations to track usage patterns, identify areas of improvement, and ultimately reduce energy consumption and costs.

Smartphone apps allow users to remotely manage appliances, lighting, and HVAC systems. This not only enhances convenience but also helps prevent unnecessary energy consumption. Lights, for example, can be turned off in unoccupied rooms with a simple tap on the app. Users can create customized schedules and automation rules for their devices and systems. For instance, they can program thermostats to adjust temperatures based on daily routines, promoting energy-efficient operation (Kalasova et al., 2021).

Smartphone applications can integrate with renewable energy sources such as solar panels and wind turbines. This enables users to monitor energy generation and consumption, maximizing their use of clean energy and minimizing reliance on the grid. Users can participate in demand response programs through these apps, allowing them to earn incentives for reducing their energy consumption during peak periods. This not only benefits users but also contributes to grid stability and reliability.

Many applications educate users about their environmental impact. By raising awareness of energy usage, these apps encourage sustainable practices and motivate users to reduce their energy consumption, thereby lowering their carbon footprint. Smartphone applications play a role in reducing traffic congestion and promoting eco-friendly transportation choices. Real-time traffic updates and navigation services guide users along the most efficient routes, reducing fuel consumption and emissions (Dutta et al., 2019).

Efficient waste collection and recycling are facilitated by these apps. They enable the scheduling of waste collection based on real-time data and encourage recycling and composting practices, contributing to energy efficiency and environmental sustainability. Users can enhance security and reduce energy usage by remotely monitoring and controlling surveillance systems through smartphone apps. This feature not only provides peace of mind but also contributes to efficient energy management.

Smartphone apps optimize heating and cooling systems, improving comfort and well-being in homes and buildings. This ensures that energy is used efficiently without sacrificing occupant comfort. By participating in demand response programs and monitoring energy usage, smartphone apps contribute to grid stability and reliability. This is essential for ensuring that cities have a consistent and dependable power supply (Boichuk, 2020).

Table 3 highlighting some of the common problems and challenges associated with the usage of smartphone applications in energy efficiency management within smart cities.

**Table 3.**

*Problems of using smartphone applications in energy efficiency management within smart cities*

Problem	Description
<b>Data Privacy and Security</b>	Concerns about the protection of personal or sensitive data when using these applications can be a significant issue. Users may worry about their data being vulnerable to cyberattacks or misuse.
<b>Limited Adoption and Accessibility</b>	Not everyone has access to smartphones or may not be comfortable using these apps, potentially leaving certain demographics or groups without the benefits of energy efficiency management.
<b>Interoperability and Compatibility</b>	The compatibility of various devices, systems, and applications can be a challenge. Ensuring that different components can work together seamlessly is a common hurdle.
<b>Reliability and Downtime</b>	Smart city applications may experience downtime or technical issues that could disrupt energy management. Dependence on technology can sometimes lead to inconvenience.
<b>Cost and Affordability</b>	The initial setup and ongoing costs of smart devices and their associated apps can be a barrier for some individuals or organizations, limiting their ability to invest in energy-efficient solutions.
<b>Digital Divide</b>	Not all residents of a smart city may have equal access to smartphones or high-speed internet, creating a digital divide that hinders the widespread adoption of energy efficiency applications.
<b>User Education and Awareness</b>	Some users may not be fully aware of the benefits and capabilities of these applications, which can lead to underutilization and missed opportunities for energy savings.
<b>Complexity and Learning Curve</b>	Smartphone apps for energy management can be complex, requiring users to learn how to operate them effectively. Some may find this learning curve challenging.

Cont. table 3.

<b>Dependence on the Grid</b>	In cases where smartphone applications rely on the grid for real-time data and control, power outages or grid failures can limit their effectiveness, especially during emergencies.
<b>Maintenance and Updates</b>	Ongoing maintenance and software updates are essential for keeping these applications secure and functional. Neglecting these aspects can lead to vulnerabilities and performance issues.
<b>Lack of Internet Connectivity</b>	Smart city applications depend on internet connectivity, and areas with poor or no internet access may face limitations in utilizing these tools for energy management.
<b>Sustainability Concerns</b>	The production and disposal of smartphones and related hardware may have environmental implications. Ensuring the sustainability of these technologies is an ongoing challenge.
<b>Privacy Invasion</b>	Some users may feel that using these applications invades their privacy by collecting data on their habits, routines, and preferences, raising concerns about surveillance and data use.

Source: (Kalasova et al., 2021; Chmielarz et al., 2021; Rose et al., 2021; Dutta et al., 2019; Ivani, Biro-Szigeti, 2019; Leal et al., 2023; Chowdhury et al., 2023; Sanchez et al., 2018; Aguilera, Boutueil, 2018).

The integration of smartphone applications into energy efficiency management within smart cities offers numerous benefits, as previously discussed. However, it's important to recognize that there are challenges and problems associated with the use of these applications in the context of energy efficiency. Smartphone applications used for energy efficiency management often collect and process sensitive data related to a user's behavior and energy consumption patterns. This data can be vulnerable to security breaches or misuse, raising concerns about privacy and the potential for cyberattacks.

Not all residents of smart cities have access to smartphones, and some may not be comfortable using these applications. This limitation could result in certain demographics or groups being excluded from the benefits of energy efficiency management. The compatibility of various devices, systems, and applications used for energy efficiency can be a significant challenge. Ensuring that different components can work together seamlessly is essential to achieving an integrated and efficient energy management system (Benevolo et al., 2016; Kalasova et al., 2021).

Smart city applications may experience downtime or technical issues, which could disrupt energy management. Dependence on technology can sometimes lead to inconvenience and operational disruptions. The initial setup and ongoing costs of smart devices and their associated apps can be a barrier for some individuals or organizations. This financial constraint may limit their ability to invest in energy-efficient solutions. The digital divide can manifest in smart cities, with not all residents having equal access to smartphones or high-speed internet. This disparity can hinder the widespread adoption of energy efficiency applications.

Some users may not be fully aware of the benefits and capabilities of these applications, leading to underutilization and missed opportunities for energy savings. Promoting user education and awareness is crucial. Smartphone apps for energy management can be complex and may require users to learn how to operate them effectively. Some individuals may find this learning curve challenging, leading to suboptimal usage. In cases where smartphone

applications rely on the grid for real-time data and control, power outages or grid failures can limit their effectiveness, especially during emergencies. This dependence on a centralized infrastructure may introduce vulnerabilities (Wolniak, 2016; Czerwińska-Lubszczyk et al., 2022; Drozd, Wolniak, 2021; Gajdzik, Wolniak, 2021, 2022; Gębczyńska, Wolniak, 2018, 2023; Grabowska et al., 2019, 2020, 2021).

Ongoing maintenance and software updates are crucial for keeping these applications secure and functional. Neglecting these aspects can lead to vulnerabilities and performance issues. Smart city applications depend on reliable internet connectivity. Areas with poor or no internet access may face limitations in utilizing these tools for energy management. The production and disposal of smartphones and related hardware may have environmental implications. Ensuring the sustainability of these technologies and their responsible end-of-life management is an ongoing challenge. Some users may feel that using these applications invades their privacy by collecting data on their habits, routines, and preferences. Concerns about surveillance and data use can lead to user resistance and hesitance.

### 3. Conclusion

Energy efficiency management in smart cities, facilitated by smartphone applications, is a vital component of creating sustainable, environmentally friendly urban environments. These applications empower users and organizations to take control of their energy consumption, contributing to the broader goal of making cities more energy-efficient. Smartphone apps offer real-time data insights, remote control capabilities, and a wealth of information about sustainable practices, making them integral to the success of energy efficiency in smart cities.

Smartphone applications enable users to remotely control and monitor various aspects of their homes and workplaces, from appliances and lighting to HVAC systems. The real-time data collected from sensors embedded in smart city infrastructure allows for optimal energy management, route optimization, and efficient energy demand prediction.

The advent of the Internet of Things has made smart devices and appliances ubiquitous in modern homes and commercial buildings. Smartphone apps are at the forefront of enabling users to control and monitor these devices, contributing to energy efficiency. Real-time data on energy consumption patterns helps users make informed decisions to reduce energy wastage and costs.

Smartphone apps not only provide convenience but also promote customization and automation, allowing users to schedule and automate tasks for energy-efficient operation. Participation in demand response programs and integration with renewable energy sources further enhance energy efficiency in smart cities.

These applications play a pivotal role in promoting eco-friendly commuting and waste management optimization. Moreover, they educate users about their environmental impact and suggest ways to reduce energy consumption and live more sustainably.

While smartphone applications offer numerous advantages, they are not without their challenges. Concerns about data privacy and security, limited adoption, compatibility issues, and user education must be addressed. Reliability and affordability can be stumbling blocks, and the digital divide can create inequalities in access. Dependence on the grid, maintenance, and sustainability concerns also require attention, and some users may raise privacy-related objections.

In light of these challenges, it is essential for smart city planners and developers to work towards solutions that mitigate these problems and create a more inclusive and secure energy management ecosystem. By doing so, we can harness the full potential of smartphone applications to create energy-efficient, sustainable, and livable smart cities.

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## THE APPLICATION OF BUSINESS ANALYTICS IN COST REDUCTION

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**Purpose:** The purpose of this publication is to present the applications of usage of business analytics in cost reduction.

**Design/methodology/approach:** Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

**Findings:** The application of business analytics in cost reduction is paramount in today's fiercely competitive business landscape. This article highlights the pivotal role of business analytics in optimizing financial performance by identifying inefficiencies and areas for cost reduction. By harnessing the power of data, business analytics enables data-driven decision-making, differentiates between cost drivers, streamlines processes, and optimizes inventory and pricing strategies. Various methodologies and techniques, along with a diverse range of software solutions, support organizations in their cost reduction endeavors. Leveraging analytics not only provides a competitive edge but also enhances customer satisfaction, mitigates financial risks, and optimizes supplier relationships. This multifaceted approach empowers organizations to achieve cost reduction goals and secure long-term financial success.

**Keywords:** business analytics, Industry 4.0, digitalization, artificial intelligence, real-time monitoring; cost, cost reduction.

**Category of the paper:** literature review.

### 1. Introduction

The application of business analytics in cost reduction has emerged as a crucial strategy for organizations across various industries. In today's competitive business landscape, companies are constantly seeking ways to enhance their profitability and sustainability, and business analytics plays a pivotal role in achieving these goals. This article delves into the importance of business analytics in cost reduction, the methodologies involved, and the benefits it offers to

organizations (Wolniak, 2016; Czerwińska-Lubszczyk et al., 2022; Drozd, Wolniak, 2021; Gajdzik, Wolniak, 2021, 2022; Gębczyńska, Wolniak, 2018, 2023; Grabowska et al., 2019, 2020, 2021; Wolniak et al., 2023; Wolniak, Grebski, 2023; Wolniak, Skotnicka-Zasadzień, 2023; Jonek-Kowalska, Wolniak, 2023).

Cost reduction is a fundamental objective for businesses, as it directly impacts the bottom line. By implementing business analytics, organizations can gain valuable insights into their operations, uncover inefficiencies, and identify opportunities to optimize costs.

The purpose of this publication is to present the applications of usage of business analytics in cost reduction.

## **2. Cost reduction and business analytics usage**

Business analytics harnesses the power of data and turns it into actionable insights. By analyzing historical and real-time data, organizations can make informed decisions that drive cost reduction strategies. Data-driven decisions are more accurate and precise compared to traditional, gut-feel approaches. Analytics allows organizations to identify the primary drivers of their costs. It helps in distinguishing between fixed and variable costs, understanding cost allocation, and pinpointing areas with the highest cost impact. This knowledge is essential for cost optimization.

Analytics can uncover inefficiencies within business processes. Through process mining and analysis, organizations can identify bottlenecks, redundancies, and waste in their operations. This insight enables them to streamline processes and reduce operational costs (Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Wolniak, 2011, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Gajdzik, Wolniak, 2023; Wolniak, 2013, 2016; Hys, Wolniak, 2018). Advanced analytics tools can help in predicting customer demand with a high degree of accuracy. This aids in optimizing inventory levels, reducing carrying costs, and avoiding stockouts or overstock situations, all of which impact costs (Adel, 2022).

Analytics can assist in setting optimal pricing strategies. By analyzing customer behavior and market trends, organizations can determine the right price points for their products and services, maximizing revenue and profitability.

Several methodologies and techniques are employed in the application of business analytics for cost reduction (Du et al., 2023; Fjellström, Osarenkhoe, 2023; Castro et al., 2014; Wang et al., 2023):

- **Descriptive Analytics:** This involves summarizing historical data to gain a better understanding of past performance and trends, which can help identify areas of cost inefficiency.



- **Predictive Analytics:** By using statistical and machine learning models, organizations can forecast future costs and identify potential cost-saving opportunities. These include:
- **Prescriptive Analytics:** This goes beyond prediction to provide recommendations for actions that can reduce costs. It can suggest strategies for optimizing supply chains, procurement, and resource allocation.
- **Process Mining:** Process mining is a technique used to analyze and visualize business processes, helping to uncover inefficiencies, bottlenecks, and opportunities for improvement.
- **Regression Analysis:** Regression models can be employed to understand the relationship between various factors and costs. This can assist in cost control and cost reduction strategies.

Table 1 contains descriptions of how business analytics is used cost reduction. This table highlights various facets of how business analytics can be applied to cost reduction, demonstrating its versatility and importance in driving cost-saving strategies for organizations.

**Table 1.**  
*The usage of business analytics in cost reduction*

Aspect	Description
Data Analysis and Insights	Data analysis is at the heart of business analytics for cost reduction. By meticulously examining historical and real-time data, organizations can extract valuable insights. This process involves uncovering patterns, trends, and anomalies within the data. These insights are essential for identifying areas of inefficiency, understanding the cost structure, and revealing opportunities to optimize costs. It enables organizations to make informed decisions, leading to effective cost reduction strategies.
Predictive Analytics	Predictive analytics takes data analysis a step further by utilizing statistical and machine learning models to forecast future costs. These models are trained on historical data to make predictions about upcoming cost trends. By understanding how costs are likely to evolve, organizations can plan and allocate resources more effectively. This not only allows them to respond to cost challenges proactively but also helps in identifying and mitigating potential areas for cost reduction before they escalate.
Process Optimization	Process optimization is a critical component of business analytics. Through techniques such as process mining, organizations can analyze their internal operations in great detail. Process mining visualizes the entire workflow, highlighting bottlenecks, redundancies, and areas of waste. By identifying these inefficiencies, organizations can streamline their processes, reducing operational costs. This results in better resource utilization, improved productivity, and ultimately, substantial cost savings.
Demand Forecasting	Accurate demand forecasting is vital for cost reduction in various industries. Business analytics leverages historical data, market trends, and customer behavior to predict future demand with precision. Organizations can optimize their inventory levels and supply chain management accordingly. By preventing stockouts and overstock situations, they minimize carrying costs and ensure they meet customer demand, all of which have a direct impact on reducing operational expenses.
Pricing Strategy	Analytics plays a pivotal role in setting the right pricing strategy. By analyzing customer behavior, market dynamics, and competition, organizations can determine the optimal price points for their products or services. This ensures that they maximize revenue while maintaining profitability. Proper pricing strategies can significantly reduce the likelihood of underpricing or overpricing, which can have a substantial influence on overall cost management and financial performance.

Cont. table 1.

Cost Driver Identification	Understanding what drives costs is fundamental to cost reduction. Business analytics helps organizations identify and categorize their cost drivers. It distinguishes between fixed and variable costs, clarifies cost allocation methods, and pinpoints areas with the most significant cost impact. By recognizing these drivers, organizations can target specific areas for cost reduction initiatives, ultimately leading to more efficient cost management and improved financial health.
Resource Allocation	Efficient resource allocation is a key benefit of business analytics. By analyzing data related to resource allocation and utilization, organizations can optimize the allocation of personnel, equipment, and materials. This ensures that resources are used efficiently, reducing waste and unnecessary expenditures. Proper resource allocation contributes significantly to cost reduction by minimizing inefficiencies and streamlining operations.
Data-Driven Decision-Making	Business analytics promotes a culture of data-driven decision-making within organizations. This approach emphasizes using data and evidence to guide choices and actions. By relying on analytics for decision-making, organizations ensure that their strategies and initiatives are based on a sound understanding of their data. Data-driven decisions are typically more accurate, precise, and aligned with organizational goals, resulting in more effective cost reduction strategies and outcomes.
Competitive Advantage	Leveraging analytics for cost reduction provides a significant competitive advantage. Organizations that can offer products or services at more competitive prices or with higher margins have a stronger market position. By optimizing costs and resource utilization, businesses can position themselves more favorably in the market, which can lead to increased market share, customer retention, and overall profitability. A competitive edge in cost management can be a key differentiator in today's competitive business landscape.
Customer Satisfaction	Business analytics has a direct impact on customer satisfaction. By aligning inventory levels, ensuring product availability, and implementing effective pricing strategies, organizations can enhance their ability to meet customer expectations. Satisfied customers are more likely to remain loyal and engage in repeat business, which can lead to long-term financial success. Moreover, customer satisfaction can be closely tied to cost reduction efforts, as efficient operations and pricing strategies contribute to improved customer experiences.
Risk Mitigation	Business analytics is instrumental in identifying and mitigating financial risks. By analyzing historical data and financial trends, organizations can detect potential financial risks early on. This enables them to implement strategies to mitigate or manage these risks effectively, reducing the financial impact and safeguarding the bottom line. Risk mitigation through analytics contributes to overall cost reduction by preventing unexpected financial setbacks.
Supplier and Vendor Optimization	Businesses rely on suppliers and vendors for various goods and services. Business analytics can be used to optimize relationships with suppliers and vendors. It helps in negotiating better terms, managing contracts efficiently, and identifying cost-saving opportunities. Effective supplier and vendor optimization can lead to reduced procurement costs and more favorable terms, directly impacting cost reduction efforts.
Cost Benchmarking	Analytics enables organizations to benchmark their costs against industry standards and competitors. By comparing their cost structure with industry peers, organizations can identify areas where they might be over-spending or underperforming. This helps in setting realistic cost reduction goals and tailoring strategies to align with industry best practices, ultimately resulting in more effective cost management and financial performance.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023).

### 3. Software used in personalized customer experience

In today's highly competitive business environment, organizations are continually seeking ways to optimize their operations and reduce costs while maintaining or even enhancing the quality of their products or services (Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020;

Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022). This drive for efficiency and cost reduction has given rise to the widespread adoption of business analytics tools and software. Business analytics software is instrumental in helping organizations analyze their operations, identify inefficiencies, and make data-driven decisions to cut costs and enhance profitability. In this article, we will explore several software solutions commonly used in business analytics for cost reduction (Zeng et al., 2022; Pech, Vrchota, 2022).

Microsoft Excel, while not traditionally considered a dedicated business analytics tool, is a ubiquitous and versatile spreadsheet software used by organizations of all sizes. Excel provides fundamental features for data analysis, visualization, and modeling, making it an accessible entry point for businesses exploring cost reduction through analytics. Users can perform tasks such as data sorting, filtering, pivot tables, and basic financial modeling. While Excel is not as advanced as other dedicated analytics platforms, it can be a cost-effective solution for small to medium-sized businesses or as an initial step toward more advanced tools.

Tableau is a powerful data visualization tool that empowers organizations to create interactive and shareable dashboards. One of its key strengths is the ability to connect to various data sources and quickly transform raw data into insightful visualizations. These visualizations facilitate data exploration, helping organizations identify cost trends, inefficiencies, and opportunities for optimization. Tableau's intuitive interface allows users to create dynamic dashboards that can be used to monitor key performance indicators and track progress toward cost reduction goals (Ghibakholl et al., 2022).

QlikView and Qlik Sense are prominent business intelligence and data visualization tools. These platforms offer in-memory data processing, which enables users to explore data interactively and create dynamic dashboards. Qlik tools are particularly valuable for organizations seeking insights into cost drivers and process optimization. By allowing users to dig deeper into the data and generate real-time insights, QlikView and Qlik Sense support cost reduction efforts by improving operational efficiency.

SAP BusinessObjects is a comprehensive suite of business intelligence tools designed for organizations with complex data requirements. It offers features for data reporting, ad hoc analysis, and dashboard creation. SAP BusinessObjects is invaluable for organizations that want to analyze and optimize costs within the context of their broader enterprise systems and data sources. It provides a centralized platform for accessing and analyzing data, helping organizations make informed decisions about cost reduction strategies (Akundi et al., 2022).

IBM Cognos Analytics is a robust business intelligence platform that offers reporting, dashboarding, and analytics capabilities. It is highly effective for organizations looking to analyze historical and real-time data, create financial models, and explore various cost reduction strategies. Cognos Analytics provides a comprehensive solution for organizations seeking a single platform to support their analytics and cost reduction initiatives (Jonek-Kowalska,

Wolniak, 2021, 2022; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021).

SAS Analytics is a powerful platform for data analysis, predictive modeling, and advanced analytics. Organizations use SAS to delve into their data and gain insights that help forecast future costs. SAS Analytics is particularly useful in identifying areas where cost savings can be achieved. By using statistical and machine learning models, SAS enables organizations to make informed decisions and execute cost reduction strategies based on data-driven insights (Scappini, 2016).

R is a popular open-source programming language and software environment used for statistical computing and graphics. Organizations with advanced analytics needs often turn to R to build custom cost reduction models and perform in-depth statistical analysis. R provides extensive flexibility and control, making it ideal for organizations with skilled data scientists who can develop tailored cost prediction and optimization models (Cillo et al., 2022).

Python, another open-source language, is widely used for data analysis, modeling, and machine learning. Python's ecosystem of libraries and frameworks makes it well-suited for predictive analytics and machine learning projects related to cost reduction. Organizations can leverage Python to build custom models and algorithms that suit their specific cost reduction goals (Nourani, 2021).

Alteryx is a data blending and advanced analytics platform that empowers organizations to prepare, blend, and analyze data from various sources. It simplifies the data preparation process, allowing users to combine data from disparate sources and generate insights for cost optimization. Alteryx is especially valuable for organizations seeking to streamline their data workflows and reduce manual data manipulation efforts (Charles et al., 2023).

SAP HANA is an in-memory data platform that accelerates data processing and analytics. It is beneficial for organizations dealing with large datasets and complex cost structures. SAP HANA enables real-time analytics, making it easier to analyze costs as they occur. This capability is particularly valuable for identifying inefficiencies and optimizing operations promptly, contributing to cost reduction initiatives (Greasley, 2019).

MicroStrategy is a comprehensive business intelligence and analytics platform. It provides features for data discovery, reporting, and dashboard creation. MicroStrategy's interactive dashboards and data exploration features are beneficial for identifying cost-saving opportunities and monitoring progress toward cost reduction goals. It enables organizations to create customized reports and dashboards tailored to their specific needs (Bakir, Dahlan, 2022).

Table 2 is listing examples of software and applications used in the case of cost reduction. These software tools are widely utilized in business analytics for cost reduction, each offering distinct features and capabilities to support organizations in their efforts to analyze costs, identify inefficiencies, and optimize their operations. The choice of software depends on the specific needs and resources of the organization.

**Table 2.***The usage of business analytics in cost reduction*

<b>Business Analytics Software</b>	<b>Description</b>
<b>Microsoft Excel</b>	Microsoft Excel is a versatile spreadsheet software widely used for basic data analysis and visualization. It is accessible and provides essential features for cost reduction, such as data sorting, filtering, and basic financial modeling. While it's not as advanced as other tools, it is a cost-effective starting point for small to medium-sized businesses.
<b>Tableau</b>	Tableau is a powerful data visualization tool that enables organizations to create interactive and shareable dashboards. It is valuable for cost reduction initiatives as it allows for in-depth data exploration and visualization, making it easier to identify cost trends, inefficiencies, and opportunities for optimization.
<b>QlikView/Qlik Sense</b>	QlikView and Qlik Sense are business intelligence and data visualization tools that facilitate in-memory data processing. They enable users to explore data and create dynamic dashboards, which are particularly useful for gaining insights into cost drivers and optimizing processes, ultimately reducing operational expenses.
<b>SAP BusinessObjects</b>	SAP BusinessObjects is a comprehensive suite of business intelligence tools. It provides features for data reporting, ad hoc analysis, and dashboard creation. SAP BusinessObjects is valuable for organizations looking to analyze and optimize costs within the context of their broader enterprise systems and data sources.
<b>IBM Cognos Analytics</b>	IBM Cognos Analytics is a business intelligence platform that offers reporting, dashboarding, and analytics capabilities. It is beneficial for cost reduction initiatives by providing tools to analyze historical and real-time data, create financial models, and explore various cost reduction strategies.
<b>SAS Analytics</b>	SAS Analytics is a comprehensive analytics platform that covers data management, advanced analytics, and predictive modeling. It is valuable for cost reduction through predictive analytics, helping organizations forecast future costs and identify areas where savings can be achieved.
<b>R</b>	R is a popular open-source programming language and software environment for statistical computing and graphics. It is ideal for organizations with advanced analytics needs and skilled data scientists. R can be used to build custom cost reduction models and perform in-depth statistical analysis to optimize expenses.
<b>Python</b>	Python, another open-source language, is widely used for data analysis, modeling, and machine learning. It is particularly valuable for predictive analytics and machine learning projects related to cost reduction, allowing organizations to build custom cost prediction and optimization models.
<b>Alteryx</b>	Alteryx is a data blending and advanced analytics platform that empowers organizations to prepare, blend, and analyze data from various sources. It is useful for cost reduction through data preparation, combining data from disparate sources, and generating insights for cost optimization efforts.
<b>SAP HANA</b>	SAP HANA is an in-memory data platform that accelerates data processing and analytics. It is useful for organizations with large datasets and complex cost structures. SAP HANA allows for real-time analytics, making it easier to analyze costs as they occur, identify inefficiencies, and optimize operations promptly.
<b>MicroStrategy</b>	MicroStrategy is a business intelligence and analytics platform that offers robust data discovery and reporting capabilities. It is valuable for cost reduction through its interactive dashboards and data exploration features, which help in identifying cost-saving opportunities and monitoring progress towards cost reduction goals.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023; Castro et al., 2014; Wang et al., 2023; Du et al., 2023; Fjellström, Osarenkhoe, 2023; Zeng et al., 2022; Pech, Vrchota, 2022).

## 4. Conclusion

The application of business analytics in cost reduction is a critical strategy for organizations in today's competitive business landscape. This article has underscored the significance of business analytics in the context of cost reduction, outlining the methodologies and benefits it offers to organizations seeking to optimize their financial performance. Cost reduction is a fundamental goal for businesses as it directly impacts the bottom line. Business analytics is instrumental in providing valuable insights into an organization's operations, helping identify inefficiencies and areas for cost optimization.

Business analytics harnesses the power of data, enabling organizations to make informed, data-driven decisions. This approach is more accurate and precise compared to traditional decision-making, leading to more effective cost reduction strategies. Business analytics helps organizations identify and categorize their cost drivers. It distinguishes between fixed and variable costs, clarifies cost allocation methods, and pinpoints areas with the most significant cost impact. This knowledge is essential for cost optimization.

Through techniques like process mining and analysis, organizations can identify bottlenecks, redundancies, and waste in their operations. This insight empowers them to streamline processes and reduce operational costs, resulting in better resource utilization and substantial cost savings. Accurate demand forecasting is crucial for cost reduction. Business analytics leverages historical data, market trends, and customer behavior to predict future demand with precision. This optimization of inventory levels and supply chain management minimizes carrying costs and ensures timely fulfillment of customer demand.

Analytics plays a pivotal role in setting the right pricing strategy. By analyzing customer behavior and market trends, organizations can determine optimal price points for their products and services, maximizing revenue while preserving profitability. Various methodologies and techniques are employed in the application of business analytics for cost reduction, including descriptive analytics, predictive analytics, prescriptive analytics, process mining, regression analysis, and more.

A range of software solutions is available to support organizations in their cost reduction efforts. These include well-known tools like Microsoft Excel, Tableau, QlikView, SAP BusinessObjects, IBM Cognos Analytics, SAS Analytics, R, Python, Alteryx, SAP HANA, and MicroStrategy, each offering distinct features and capabilities tailored to different organizational needs and levels of expertise. Leveraging analytics for cost reduction provides a significant competitive advantage. It positions organizations favorably in the market, which can lead to increased market share, customer retention, and overall profitability. Efficient operations and pricing strategies also enhance customer satisfaction.

Business analytics assists in identifying and mitigating financial risks, preventing unexpected financial setbacks. It also supports optimizing relationships with suppliers and vendors, helping negotiate better terms and identifying cost-saving opportunities. Analytics enables organizations to benchmark their costs against industry standards and competitors, aiding in setting realistic cost reduction goals and aligning strategies with industry best practices.

The application of business analytics in cost reduction is a multifaceted and indispensable approach for organizations seeking to enhance their financial health and competitiveness. By harnessing data-driven insights, identifying inefficiencies, optimizing processes, and making informed decisions, businesses can embark on a journey toward more efficient operations, improved customer satisfaction, and a stronger competitive position. The choice of software tools and methodologies should align with an organization's specific needs and resources, ultimately contributing to the achievement of cost reduction goals and long-term financial success.

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## THE USAGE OF SIX SIGMA IN INDUSTRY 4.0 CONDITIONS

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**Purpose:** The purpose of this publication is to present the usage of Six Sigma approach in Industry 4.0 conditions.

**Design/methodology/approach:** Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

**Findings:** The integration of Six Sigma principles with the dynamic landscape of Industry 4.0 offers a promising synergy that brings numerous benefits and challenges. Industry 4.0, characterized by advanced technologies like IoT, big data analytics, AI, and robotics, is reshaping manufacturing and industry. This digital revolution demands adaptability and process optimization for efficiency, quality, and customer satisfaction. Six Sigma, grounded in data-driven process improvement, aligns well with Industry 4.0's goals. Combining these approaches can yield remarkable results, enhancing competitiveness and driving continuous quality and efficiency improvement. Six Sigma's DMAIC methodology, defining, measuring, analyzing, improving, and controlling, offers a structured approach for problem-solving. A hierarchy of roles ensures effective project management and expertise utilization. Real-world applications across various sectors support the integration of Six Sigma and Industry 4.0, aiming to enhance product or service quality, efficiency, and customer satisfaction. The advantages of using Six Sigma in Industry 4.0 conditions are substantial, including improved quality control, enhanced data-driven decision-making, real-time process monitoring, predictive maintenance optimization, process efficiency improvement, and streamlined supply chain management, ultimately leading to higher customer satisfaction, cost reduction, employee skill development, competitive advantage, and improved risk management. However, this integration presents challenges like data overload, complex technology integration, skill gaps, data security, process complexity, change management, implementation costs, and over-reliance on technology. These issues can be addressed through advanced data analytics, well-defined integration strategies, comprehensive training, robust cybersecurity measures, simplification of processes, effective change management, compelling business cases, and maintaining a balanced approach. In a rapidly evolving industrial landscape, integrating Six Sigma with Industry 4.0 offers a promising path for organizations to enhance quality, efficiency, and competitiveness while addressing the challenges of digital transformation.

**Keywords:** Industry 4.0; Quality 4.0, quality management; quality methods, Six Sigma.

**Category of the paper:** literature review.

## 1. Introduction

In today's rapidly evolving industrial landscape, where technology and automation are at the forefront, the application of Six Sigma principles has become more crucial than ever before. Industry 4.0, often referred to as the fourth industrial revolution, is characterized by the integration of advanced technologies such as the Internet of Things (IoT), big data analytics, artificial intelligence, and robotics into manufacturing processes. This digital transformation presents both challenges and opportunities for businesses, making it essential to adapt and optimize processes to ensure efficiency, quality, and customer satisfaction. This text explores the integration of Six Sigma methodologies in Industry 4.0 conditions, highlighting the benefits, challenges, and real-world applications (Wolniak, Sułkowski, 2015, 2016; Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022).

Industry 4.0 aims to create smart, interconnected manufacturing systems that are capable of self-monitoring, self-diagnosing, and self-optimizing. Six Sigma, on the other hand, is a data-driven approach to process improvement that focuses on minimizing defects and variations to achieve higher quality and consistency. Combining these two approaches can yield remarkable results.

The purpose of this publication is to present the usage of Six Sigma approach in Industry 4.0 condition.

## 2. The basics of Six Sigma approach

Six Sigma, a powerful concept that originated from Motorola in the 1980s and was further popularized by General Electric, has become synonymous with process improvement and excellence in many industries. This two-page text delves into the fundamental principles and methodologies of Six Sigma, highlighting its core components and applications (Bousdekis et al., 2023).

Six Sigma is a systematic and data-driven methodology for process improvement. It aims to minimize defects and variations in any process, product, or service to achieve a level of near-perfection, with an error rate of 3.4 defects per million opportunities. The term "Six Sigma" itself reflects this goal, as it refers to the six standard deviations within the normal distribution curve, with the goal of keeping defects within the range of  $\pm 6\sigma$ .

Six Sigma employs the DMAIC methodology, which stands for Define, Measure, Analyze, Improve, and Control. This structured approach guides organizations through the process of identifying issues, measuring performance, analyzing root causes, making improvements, and ensuring sustainability (Barsalou, 2023; Maganga, Taifa, 2023):

- **Define:** This phase involves defining the problem, setting objectives, and understanding customer requirements.
- **Measure:** Measurement is key to Six Sigma, as it provides data to assess current process performance and establish a baseline.
- **Analyze:** In this phase, data is analyzed to identify the root causes of defects and inefficiencies.
- **Improve:** With a deep understanding of the problem, teams work to make necessary improvements and optimize the process.
- **Control:** Finally, control measures are put in place to ensure that the improvements are sustained over time.

Six Sigma initiatives typically involve a hierarchy of roles, with each person contributing to the project's success (Antony et al., 2023; Escobar et al., 2023; Antony et al., 2023; Salimbeni & Redchuk, 2023):

- **Champion:** High-level executives who sponsor and support Six Sigma initiatives.
- **Master Black Belt:** Experts who provide guidance and mentor Green and Black Belts.
- **Black Belt:** Project leaders who drive improvement projects.
- **Green Belt:** Team members who support Black Belts in their projects.
- **Yellow Belt:** Employees with basic Six Sigma knowledge who may participate in projects on a limited scale.

Table 1 contains description of typical applications of Six Sigma.

**Table 1.**  
*Examples of applications of Six Sigma*

Industry/Sector	Application of Six Sigma	Description
Manufacturing	Defect Reduction	Six Sigma is used to minimize defects and improve product quality in manufacturing processes.
Healthcare	Patient Care Improvement	In healthcare, Six Sigma is applied to enhance patient care, reduce medical errors, and optimize hospital operations.
Financial Services	Process Optimization	In the financial sector, Six Sigma is used to streamline financial processes, minimize errors, and enhance risk management.
Customer Service	Service Quality Enhancement	In customer service, Six Sigma is employed to improve response times, reduce customer complaints, and enhance service quality.
Supply Chain	Inventory Management	Six Sigma helps optimize inventory management, reduce carrying costs, and ensure supply chain efficiency.
Information Technology	Software Development Quality Assurance	Six Sigma is applied to software development processes to improve quality, reduce defects, and enhance reliability.
Aerospace	Safety and Quality Improvement	In the aerospace industry, Six Sigma is used to enhance safety, reduce defects in components, and ensure product quality.

Cont. table 1.

Education	Academic Performance Improvement	In education, Six Sigma can improve academic outcomes by identifying and addressing factors affecting student performance.
Retail	Inventory and Stock Management	Retailers use Six Sigma to optimize inventory and stock management, reducing overstock or out-of-stock issues.
Construction	Project Management Efficiency	In construction, Six Sigma principles are applied to improve project management, reduce delays, and control costs.

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

### 3. How Six Sigma approach can be integrated with Industry 4.0 and Quality 4.0 concept

In Industry 4.0, data is abundant. Machines and sensors generate vast amounts of information. Six Sigma complements this by providing a structured framework for analyzing and utilizing this data. Companies can harness the power of advanced analytics and statistical tools to identify patterns, detect anomalies, and continuously improve processes (Jonek-Kowalska, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Wolniak, 2021, 2022; Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecula, Wolniak, 2022; Olkiewicz et al., 2021) Data-driven decision-making is a cornerstone of both Six Sigma and Industry 4.0, ensuring that changes are made based on empirical evidence rather than intuition (Sureshchandar, 2023; Saihi et al., 2023).

Industry 4.0 enables real-time monitoring of manufacturing processes, allowing for immediate intervention in case of deviations. Six Sigma principles can help define the critical parameters that should be monitored and set up control charts and alerts to identify issues before they lead to defects. This integration reduces the likelihood of defects and minimizes the cost of poor quality (Almeida, Abreu, 2023).

One of the key advantages of Industry 4.0 is predictive maintenance, which uses sensors and data analytics to predict when equipment is likely to fail (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Wolniak, 2011, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Gajdzik, Wolniak, 2023; Swarnakar et al., 2023). Six Sigma methodologies can be applied to optimize the predictive maintenance process by fine-tuning algorithms and reducing false alarms. This enhances the overall equipment effectiveness (OEE) and reduces downtime (Alrabadi et al., 2023).

Implementing Industry 4.0 technologies and Six Sigma methodologies requires a skilled workforce. Companies need to invest in training and development to ensure that employees can effectively use the tools and techniques associated with both approaches. Industry 4.0 generates massive amounts of data, which may raise concerns about data security and privacy (Wolniak,

2016; Czerwińska-Lubaszczuk et al., 2022; Drozd, Wolniak, 2021; Gajdzik, Wolniak, 2021, 2022; Gębczyńska, Wolniak, 2018, 2023; Grabowska et al., 2019, 2020, 2021). Companies need to implement robust cybersecurity measures to protect sensitive information (Jokovic et al., 2023).

Integrating these two approaches into existing processes can be complex. Companies must develop a clear strategy and roadmap for adoption, ensuring that Six Sigma principles are seamlessly integrated into the new digital infrastructure (Yanamandra et al., 2023).

The integration of Six Sigma with the Quality 4.0 concept represents a powerful symbiosis that leverages data, automation, and structured methodologies to enhance quality, efficiency, and competitiveness in today's industrial landscape (Liu et al., 2023). As organizations navigate the challenges and opportunities presented by the digital transformation, the strategic alignment of Six Sigma with Quality 4.0 emerges as a cornerstone for success, where data-driven decision-making, continuous improvement, proactive quality management, cost reduction, and process optimization become pivotal drivers for achieving and sustaining excellence (Singh et al., 2023). In a world where the quality bar continues to rise, the collaboration between Six Sigma and Quality 4.0 is the answer to achieving near-perfection in product and service quality (Maganga, Taifa, 2023).

Table 2 is listing examples of integration of Six Sigma approach with Industry 4.0. The integration of Six Sigma and Industry 4.0 represents a powerful synergy that leverages data, automation, and structured methodologies to enhance quality, efficiency, and competitiveness in today's rapidly evolving industrial landscape.

**Table 2.**  
*Six Sigma integration with Industry 4.0*

Aspect	Description
Data-Driven Decision-Making	Industry 4.0 generates vast amounts of data through IoT sensors and automation. Six Sigma provides the structured framework for analyzing this data, making evidence-based decisions, and identifying areas for improvement.
Real-Time Process Monitoring	Industry 4.0 enables real-time monitoring of manufacturing processes, allowing for immediate intervention in case of deviations. Six Sigma principles can be integrated to define critical parameters, set up control charts, and establish alerts for detecting and addressing issues proactively.
Predictive Maintenance	Industry 4.0's predictive maintenance uses sensors and data analytics to predict equipment failures. Six Sigma can optimize this process by fine-tuning algorithms, reducing false alarms, and ensuring maintenance activities are performed efficiently.
Quality Control and Assurance	Industry 4.0 can enhance quality control with automated inspection and data collection. Six Sigma methods can be applied to analyze this data, identify defects, and reduce variations in processes, ultimately improving product or service quality.
Process Optimization	Industry 4.0 automates and optimizes various processes. Six Sigma's DMAIC methodology can be employed to analyze and improve these processes by identifying bottlenecks, reducing waste, and enhancing overall efficiency.
Supply Chain Management	Industry 4.0 technologies provide real-time visibility into supply chain operations. Six Sigma principles can be used to improve supply chain performance, reduce lead times, and ensure on-time delivery of materials and products.
Employee Training and Development	The integration of Six Sigma and Industry 4.0 may necessitate training employees in both areas. Six Sigma training can help ensure that the workforce is equipped to handle the data-driven processes and quality improvements associated with Industry 4.0.

Cont. table 2.

Continuous Improvement Culture	The combination of Six Sigma and Industry 4.0 fosters a culture of continuous improvement, where employees use data and technology to drive ongoing enhancements in processes, products, and services.
Risk Management	Integrating Six Sigma with Industry 4.0 can also support better risk management, as data analytics and process improvements can help identify and mitigate risks more effectively.

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Amat-Lefort et al., 2023; Alrabadi et al., 2023; Singh et al., 2023; Barsalou, 2023; Antony et al., 2023; Saihi et al.2023; Sureshchandar, 2023; Swarnakar et al., 2023; Gimerska et al., 2023; Salimbeni, Redchuk, 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

Table 3 is describe the advantages of Six Sigma approach usage in industry 4.0. The use of Six Sigma in Industry 4.0 conditions offers numerous advantages, from ensuring product and service quality to optimizing processes and cost-effectiveness, ultimately enhancing an organization's competitiveness and customer satisfaction.

**Table 3.**

*The advantages of Six Sigma integration with Industry 4.0*

Advantage	Description
Improved Quality Control	Six Sigma helps ensure the highest product and service quality by reducing defects and variations, which is especially crucial in the precision-driven environment of Industry 4.0.
Enhanced Data-Driven Decision-Making	Industry 4.0 generates vast amounts of data. Six Sigma provides a structured framework for analyzing this data, enabling evidence-based decision-making and continuous improvement.
Real-Time Process Monitoring	Industry 4.0 allows for real-time process monitoring, and Six Sigma principles can be integrated to set up control charts and alerts, proactively identifying and addressing issues as they occur.
Predictive Maintenance Optimization	Six Sigma can fine-tune predictive maintenance algorithms, reducing false alarms and optimizing the process, leading to higher equipment reliability and lower downtime.
Process Efficiency Improvement	The combination of Industry 4.0's automation and Six Sigma's DMAIC methodology enables companies to analyze and optimize processes, reducing waste, improving efficiency, and reducing operational costs.
Supply Chain Optimization	Industry 4.0 technologies provide real-time supply chain visibility. By integrating Six Sigma, organizations can optimize supply chain performance, reduce lead times, and ensure on-time delivery.
Customer Satisfaction	Higher quality and reduced defects, made possible by Six Sigma in Industry 4.0, translate to improved customer satisfaction, which is crucial in competitive markets.
Cost Reduction	Reduced defects and improved efficiency often result in cost savings, making Six Sigma a valuable tool in the cost-conscious landscape of Industry 4.0.
Employee Skill Development	The integration of Six Sigma and Industry 4.0 may require employee training, leading to skill development that benefits both process automation and quality improvement.
Competitive Advantage	Companies that implement Six Sigma in Industry 4.0 conditions gain a competitive edge by delivering high-quality products, optimizing processes, and responding to customer needs quickly and effectively.
Risk Mitigation	By using data analytics and process improvements, Six Sigma helps identify and mitigate risks more effectively in the data-intensive environment of Industry 4.0.

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Amat-Lefort et al., 2023; Alrabadi et al., 2023; Singh et al., 2023; Barsalou, 2023; Antony et al., 2023; Saihi et al.2023; Sureshchandar, 2023; Swarnakar et al., 2023; Gimerska et al., 2023; Salimbeni, Redchuk, 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

Table 4 is describing the problems of Six Sigma approach usage in industry 4.0 and methods to overcome them. The use of Six Sigma in Industry 4.0 conditions offers numerous advantages, from ensuring product and service quality to optimizing processes and cost-effectiveness, ultimately enhancing an organization's competitiveness and customer satisfaction.

**Table 4.**

*The problems of Six Sigma integration with Industry 4.0*

Problems	Description of Problem	Overcoming Strategies
Data Overload	Industry 4.0 generates vast amounts of data from IoT sensors and automation, leading to information overload. This can overwhelm Six Sigma teams and hinder effective data analysis.	<ul style="list-style-type: none"> <li>• Implement advanced data analytics and machine learning tools to process, analyze, and prioritize data efficiently. Focus on actionable insights rather than all available data.</li> <li>• Define key performance indicators (KPIs) that are aligned with your objectives and focus on monitoring and analyzing these critical metrics.</li> </ul>
Technology Integration	Integrating Six Sigma with Industry 4.0 technologies such as IoT, big data, and AI can be complex, leading to disjointed processes and challenges in achieving synergy.	<ul style="list-style-type: none"> <li>• Develop a clear strategy and roadmap for technology integration, ensuring alignment with improvement goals and objectives.</li> <li>• Foster open communication and collaboration between Six Sigma teams and IT departments to facilitate seamless technology integration and process improvement.</li> </ul>
Skill Gaps	Industry 4.0 requires specialized skills for the operation and maintenance of advanced technologies, which Six Sigma teams may lack. This skills gap can hinder effective implementation.	<ul style="list-style-type: none"> <li>• Invest in comprehensive training and development programs for employees, aligning them with the specific skill sets needed for Industry 4.0.</li> <li>• Consider cross-training or hiring personnel with the required expertise to bridge the skill gaps within the organization.</li> </ul>
Data Security and Privacy	Industry 4.0 data often contains sensitive information, raising concerns about data security and privacy compliance, which is crucial for regulatory and ethical reasons.	<ul style="list-style-type: none"> <li>• Implement robust cybersecurity measures, including encryption, access controls, and intrusion detection systems, to protect sensitive data.</li> <li>• Ensure compliance with relevant data protection regulations, such as GDPR or HIPAA, to maintain data privacy and avoid legal and reputational risks.</li> </ul>
Complexity	The combination of Six Sigma and Industry 4.0 can lead to complex processes and projects that may be challenging to manage effectively.	<ul style="list-style-type: none"> <li>• Maintain a focus on the core principles of both methodologies and avoid overcomplicating processes.</li> <li>• Ensure that project teams have well-defined objectives, clear scope, and a structured approach to avoid unnecessary complexity.</li> </ul>
Change Management	The integration of Six Sigma and Industry 4.0 may lead to resistance from employees who are reluctant to adapt to new technologies and methodologies, potentially slowing down the implementation process.	<ul style="list-style-type: none"> <li>• Develop a comprehensive change management plan that includes clear and frequent communication with employees.</li> <li>• Provide adequate training and resources to help employees adapt to the new ways of working and understand the benefits of the changes.</li> </ul>

Cont. table 4.

Cost of Implementation	Implementing Industry 4.0 technologies and Six Sigma methodologies can be costly, and securing the necessary budget can be challenging.	<ul style="list-style-type: none"> <li>• Develop a well-defined business case that outlines the expected return on investment (ROI) from quality improvements and efficiency gains.</li> <li>• Prioritize projects that offer the most significant ROI to make a compelling case for funding.</li> </ul>
Over-Reliance on Technology	In the pursuit of Industry 4.0, there may be a temptation to rely excessively on technology, potentially neglecting the human element of Six Sigma and its focus on teamwork and problem-solving skills.	<ul style="list-style-type: none"> <li>• Maintain a balanced approach where technology complements human expertise rather than replacing it.</li> <li>• Continue to emphasize the human factors, such as collaboration, creativity, and critical thinking, which are integral to the success of Six Sigma projects.</li> </ul>

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Amat-Lefort et al., 2023; Alrabadi et al., 2023; Singh et al., 2023; Barsalou, 2023; Antony et al., 2023; Saihi et al.2023; Sureshchandar, 2023; Swarnakar et al., 2023; Gimerska et al., 2023; Salimbeni, Redchuk, 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

## 4. Conclusion

The integration of Six Sigma principles with the dynamic landscape of Industry 4.0 presents a compelling synergy that offers numerous advantages while also posing certain challenges. Industry 4.0, characterized by the seamless integration of advanced technologies like IoT, big data analytics, AI, and robotics, is transforming the manufacturing and industrial sectors. This digital revolution demands adaptability and optimization of processes to ensure efficiency, quality, and customer satisfaction.

The core principles of Six Sigma, rooted in data-driven process improvement, align well with the goals of Industry 4.0. Combining these two approaches can yield remarkable results, enhancing the overall competitiveness of organizations and driving continuous improvement in quality and efficiency.

Six Sigma's DMAIC methodology, encompassing Define, Measure, Analyze, Improve, and Control, provides a structured approach to problem-solving and process optimization. It guides organizations through the process of identifying issues, measuring performance, analyzing root causes, making improvements, and ensuring sustainability. A hierarchy of roles within Six Sigma initiatives ensures that projects are well-managed and that the right expertise is applied to each task.

The integration of Six Sigma and Industry 4.0 is supported by various real-world applications across diverse sectors, from manufacturing and healthcare to financial services and education, all aimed at enhancing product or service quality, efficiency, and customer satisfaction.



The advantages of employing Six Sigma in Industry 4.0 conditions are numerous. It results in improved quality control, enhanced data-driven decision-making, real-time process monitoring, predictive maintenance optimization, process efficiency improvement, and streamlined supply chain management. These benefits translate to higher customer satisfaction, cost reduction, employee skill development, competitive advantage, and improved risk management.

However, this integration also comes with its set of challenges, such as dealing with data overload, complex technology integration, skill gaps, data security and privacy concerns, process complexity, change management, implementation costs, and the risk of over-reliance on technology. These challenges can be overcome through strategic approaches such as advanced data analytics, well-defined technology integration strategies, comprehensive training programs, robust cybersecurity measures, simplification of complex processes, effective change management, sound business cases for cost justification, and maintaining a balanced approach to technology.

In a rapidly evolving industrial landscape where innovation and adaptation are key, the integration of Six Sigma with Industry 4.0 conditions represents a promising avenue for organizations to achieve higher quality, efficiency, and competitiveness while navigating the challenges posed by the digital transformation.

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## IMPROVING THE SYSTEMIC APPROACH TO INFORMATION SECURITY MANAGEMENT IN THE CONTEXT OF INCREASING THE LEVEL OF DATA PROTECTION IN LOCAL GOVERNMENT ENTITIES

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**Purpose:** The article presents the requirements of the ISO/IEC 27001 standard and the implementation status of the information security management system in Poland and worldwide. Additionally, the role of modern technologies in ensuring the security of organizations was presented and the threats that may accompany the use of technology in the aspect of personal data in public administration were indicated.

**Design/methodology/approach:** The analysis conducted allowed us to identify differences in the number of international certificates awarded and to determine the relationship between the implemented systems and the represented sectors.

**Findings:** The article identifies threats that may occur when using information technologies in the context of personal data protection, determines which of these threats pose the greatest threat to personal data processed in the analysed organizations, and identifies technological factors that influence the increase in the level of security in the context of personal data protection. The study also analyses the number of information security management system certificate according to the ISO 27001 standard, taking into account individual sectors.

**Practical implications:** The research indicates fundamental issues regarding the implementation of the information security system in Poland and around the world.

**Originality/value:** The information contained in the article discusses the relationship between the implemented international certificates and the type of services provided and verifies the world leaders in terms of the number of ISO 27001 certificates in the public administration sector.

**Keywords:** information security management system, new technologies, data protection.

**Category of the paper:** research and review publication.

## 1. Introduction

Changes taking place in the modern world have made information technology play a huge role in human functioning, and personal data have become a kind of modern currency. The aim of the article is to identify threats that may occur when using information technologies in the context of personal data protection; determining which of these threats pose the greatest threat to personal data processed in the analysed organizations and identifying technological factors that influence the increase in the level of security in the context of personal data protection. The study also analyses the number of information security management system certificates according to the ISO 27001 standard, taking into account individual sectors. The research used the diagnostic survey methods. The survey was conducted among 372 Polish local government units. The research conducted showed that by the end of 2020, 44,499 certificates of compliance with the ISO 27001 standard had been granted worldwide. Despite the growing number of ISO 27001 certificates granted worldwide, the share of certificates granted in the public administration sector is relatively small compared to other sectors. The conducted survey research allowed us to isolate factors that generate threats in the context of personal data protection. According to the surveyed local government units, the human factor, resulting from the possibility of accidental, unintentional disclosure of personal data, is a key risk category that may have a negative impact on the personal data protection process. There is a limited number of studies on the issue discussed, and it should also be pointed out that people processing data are insufficiently aware of possible threats. Analysis of the risks arising from the use of information technologies in the context of personal data security in the public sector is still a current and important trend in research, because activities aimed at limiting and counteracting risks contribute to increasing the efficiency and improving the security of organizations.

## 2. Requirements of the ISO/IEC 27001 standard and the implementation status of the information security management system in Poland and worldwide

PN-EN ISO/IEC 27001 is the most well-known standard in the world regarding the Information Security Management System (ISMS). On August 22, 2023, a new version of the PN-EN ISO/IEC 27001:2023-08 standard (English version) was published. The ISO/IEC 27001 standard is an important element of the information security management system. In the context of increasing cybercrime and the constant emergence of new threats, a key strategic task of every organization is information security management. This may seem complicated and

sometimes even unattainable. The PN-EN ISO/IEC 27001 standard is used to help organizations purposefully secure collected data, create secure data processing processes and take into account evolving external and internal risks.

PN-EN ISO/IEC 27001 promotes a holistic approach to information security, identifying key areas for building security, such as: people, processes and technologies.

The Information Security Management System, created in accordance with this standard, is an instrument for creating appropriate security measures, taking into account the context in which the organization operates, its business strategy and goals.

It sets out the necessary safeguards to ensure that personal data and/or personally identifiable information are properly managed in a transparent and systematic manner. This standard specifies the safeguards that are appropriate when an organization acts as a processor or controller of personal data. The control measures included in the standard connect the entire cycle of obtaining, analysing, storing, sharing and deleting information, thus enabling this identification. The data subject remains at the centre of the security measures applied to the requirements of the GDPR (McDonagh, 2018, p. 4).

The most important standards in the field of information security management developed by the International Organization for Standardization ISO include:

*PN-EN ISO/IEC 27000:2017-06 Information technology. Security techniques. Information security management systems. Overview and terminology.*

This International Standard presents the fundamentals of information security management systems, along with terminology often used in the ISMS set of standards. It is used by organizations of all types and sizes, such as commercial companies, government institutions and non-profit organizations.

*PN-EN ISO/IEC 27001:2023-08 Information security, cybersecurity and privacy protection. Information security management systems – Requirements.*

This document defines the criteria for creating, implementing, maintaining and improving an information security management system in an organization. It also includes requirements for assessing and managing information security risks, tailored to the needs of a given organization. The provisions contained in the document are universal and apply to all organizations, regardless of their type, size or nature. Omission of any requirement from Chapters 4 to 10 is unacceptable if the organization declares compliance with this document.

*PN-EN ISO/IEC 27002:2023-01 Information security, cybersecurity and privacy protection. Securing information.*

This document presents a reference set of information security standards along with instructions for their implementation. It was created for organizations to use in the context of an information security management system (ISMS) in accordance with ISO/IEC 27001, implement information security based on globally recognized best practices and create their own dedicated information security management guidelines.

*PN-ISO/IEC 27004:2017-07 Information technology. Security techniques. Information security management. Monitoring, measurement, analysis and evaluation.*

This document provides guidance to assist organizations in assessing their information security performance and the effectiveness of their information security management system to meet the requirements of ISO/IEC 27001. The document is suitable for organizations of all types and sizes.

*PN-EN ISO/IEC 27006:2021-05 Information technology. Security techniques. Requirements for entities auditing and certifying information security management systems.*

This International Standard defines requirements and provides guidance for institutions auditing and certifying information security management systems. Its aim is to facilitate the accreditation process for bodies certifying information security management systems.

It should be noted that as a criteria document, this International Standard may be used in accreditation, peer review or other audit processes

*PN-EN ISO 27007:2022-06 Information security, cybersecurity and privacy protection – Guidelines for auditing information security management systems*

This document provides guidance on managing an information security system, conducting audits, and qualifying information security system auditors.

ISO/IEC 27007 is intended for those who need to understand or conduct internal or external audits of an information security system, or manage an information security system audit program.

*PN-EN ISO/IEC 27017:2021-07 Information technology. Security techniques. Practical rules for information security based on ISO/IEC 27002 for cloud services*

This standard provides information security guidelines specifically designed for the provision and use of cloud services.

*PN-EN ISO/IEC 27701:2021-09 Security techniques. Extension to ISO/IEC 27001 and ISO/IEC 27002 for privacy information management. Requirements and guidelines.*

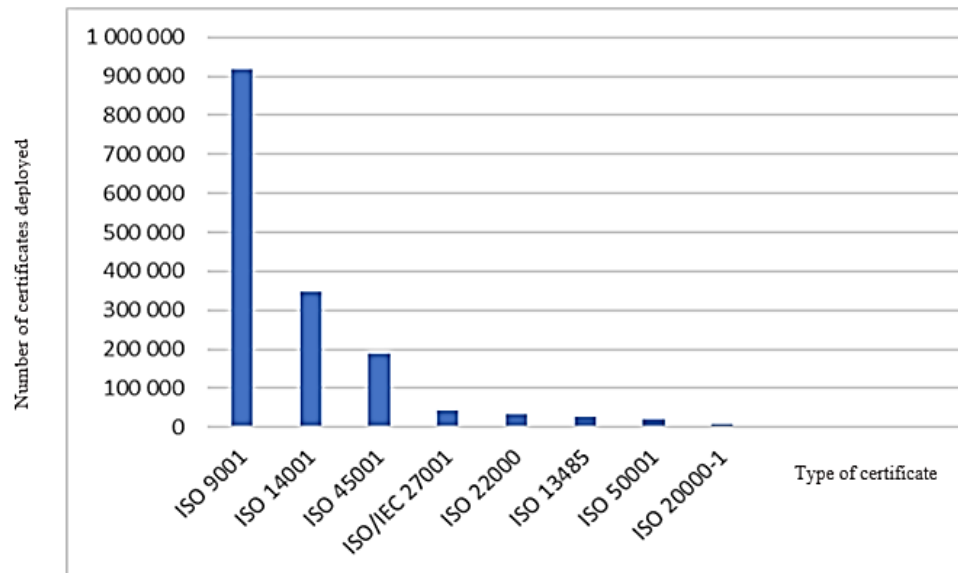
This document defines the requirements and provides guidance for the establishment, implementation, maintenance and continuous improvement of a Privacy Information Management System (PIMS) as an extension of ISO/IEC 27001 and ISO/IEC 27002 for managing privacy in an organization. It contains PIMS requirements and guidelines for personal data administrators and processors. It is used for organizations of all types and sizes, including public, private, governmental and non-commercial entities managing personal data as part of an Information Security Management System.

The research conducted showed that by the end of 2020, 44,499 certificates of compliance with the ISO 27001 standard had been granted around the world. Compared to the number of certificates obtained in 2013, which was 21,604, this value doubled in comparison to 2020.

Comparing the number of certificates obtained in the world with certificates of other management systems, it should be stated that it ranks 4<sup>th</sup> in terms of implemented systems.

The most certificates obtained by the end of 2020 concern the ISO 9001 standard – 916,842 certificates, ISO 14001 – 348,473, ISO 45001 – 190,481 and ISO/IEC 27001 – 44,499.

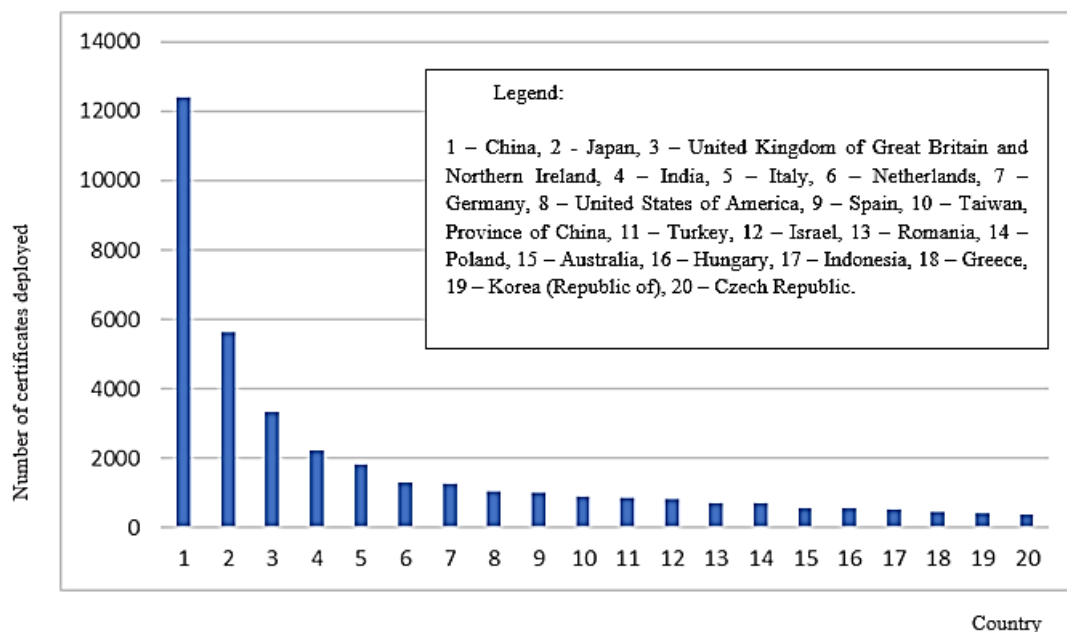
Data on the number of certificates obtained, divided into various ISO standards, is presented below (Figure 1).



**Figure 1.** Number of management system certificates in the world – as of the end of 2020.

Source: own study.

Figure 2 shows the number of ISO 27001 certificates in the 20 countries with the highest number of certificates.

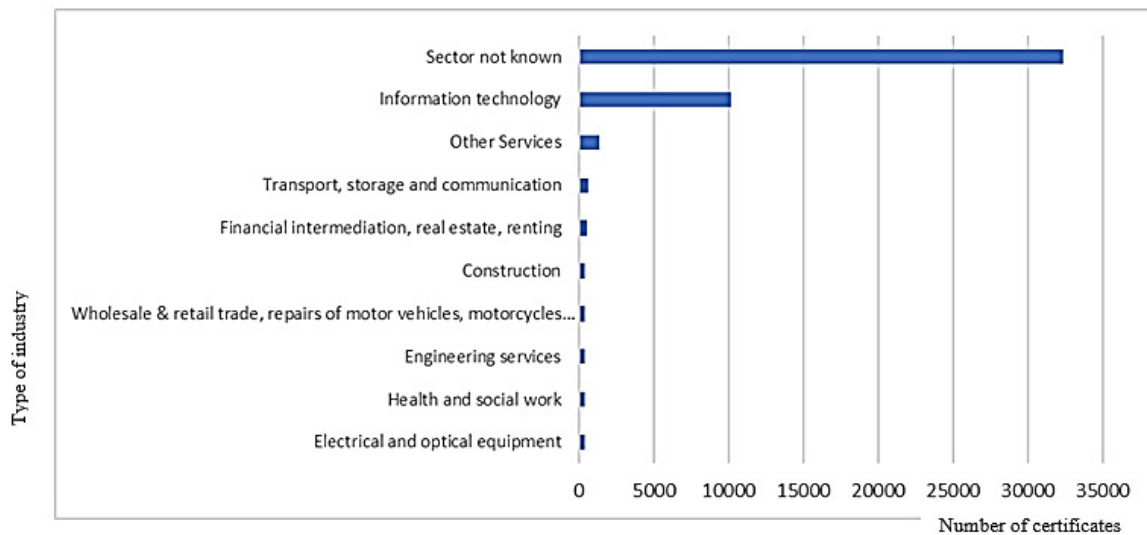


**Figure 2.** Number of ISO/IEC 27001:2013 Information technology certificates awarded. Security techniques. Information security management systems – Requirements – in 20 countries in 2020.

Source: own study.

The world leader in the number of ISO 27001 certificates obtained by the end of 2020 is China – 12,403, then Japan – 5,645, United Kingdom of Great Britain and Northern Ireland – 3,327, India – 2,226, Italy – 1,827, Netherlands – 1,326, Germany – 1,281, United States of America – 1,058, Spain – 997, Taiwan, Province of China – 10,895. Poland ranked 14<sup>th</sup> with 710 certificates.

Figure 3 presents the 10 industries with the largest number of implemented ISO 27001 certificates in 2020.



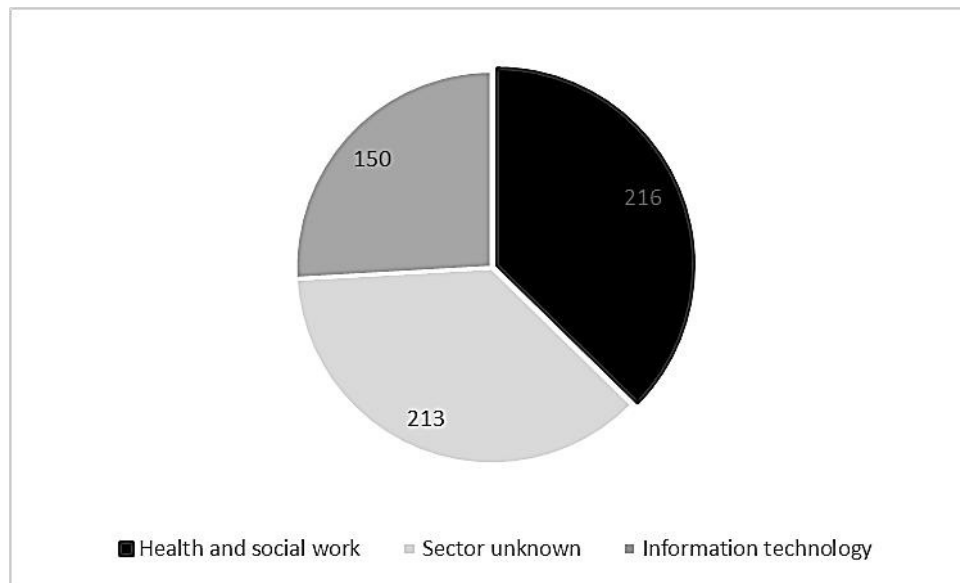
**Figure 3.** 10 industries with the largest number of implemented ISO 27001 certificates in 2020.

Source: own study.

Analysing the 10 sectors in the world in which the largest number of ISO 27001 certificates have been granted, the following can be indicated: Sector not known – 32,372, in turn – Information technology – 10,167, Other Services – 1,359, Transport, storage and communication – 620, Financial intermediation, real estate, renting – 564, Construction – 417, Wholesale & retail trade, repairs of motor vehicles, motorcycles & personal & household goods – 404, Engineering services – 399, Engineering services – 399, Health and social work – 389, Electrical and optical equipment – 388.

In Poland, the most popular sectors when it comes to the implementation of information security management systems are: Health and social work – over 30% of the total number of ISO 27001 certificates, Sector unknown – 30% of the total number of ISO 27001 certificates and Information technology – 21%.

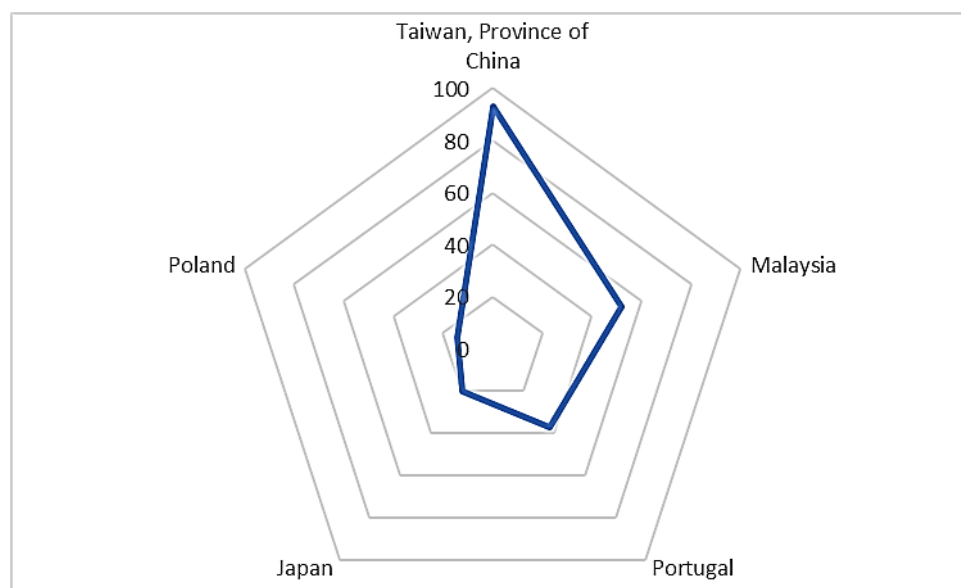




**Figure 4.** Sectors with the largest number of ISO 27001 certificates granted in Poland in 2020.

Source: own study.

Figure 5 presents the 5 countries that hold the leading position in terms of the number of certificates confirming compliance with the ISO 27001 standard in the world in the public sector.



**Figure 5.** World leaders in terms of the number of ISO 27001 certificates in the public administration sector.

Source: own study.

The world leaders in terms of ISO 17021 certificates held include: Taiwan, Province of China – 93 certificates, Malaysia – 52, Portugal – 37, Japan – 20, Poland – 14. Statistics show that despite the growing number of certificates granted in the world, relatively small is the share of certificates awarded in the public administration sector in relation to other sectors. Therefore, it is recommended to pay attention to the establishment, implementation, operation, monitoring,

review, maintenance and improvement of the Information Security Management System, because a properly implemented and certified system brings many benefits to the organization.

Information security management system according to the ISO 27001 standard:

- contributes to minimizing the risk of events related to information security,
- enables the organization to be prepared for information security incidents,
- increases the credibility of the organization in the eyes of customers, investors and shareholders (all stakeholders),
- has a positive impact on protecting and improving the organization's reputation,
- ensuring the security of the Client's interests as a result of a properly functioning information management system,
- guarantees an appropriate level of quality of protection of information assets,
- increased employee awareness of information security.

Based on the above information, it can be seen that the implementation of the Information Security System affects the quality of the services provided, therefore private, public and non-profit organizations should implement their activities based on ISO 27001.

### **3. The role of modern technologies in ensuring the security of the organization**

The dynamic development of the real and virtual world has led to the emergence of numerous benefits. However, despite the positive aspects, digitization has brought with it new forms of threats. The rapid development of technology that blurs reality has created many dangers. Thanks to computerization, new technologies and artificial intelligence introduced to all economic sectors, as well as the collection of data in IT systems, ease of access to this data has arisen. Total surveillance and loss of privacy are a huge disadvantage of new technologies that are difficult to oppose. The development of computerization has made it possible to "crack" any password, and the prospect of not being able to exchange information generates huge problems.

However, the constant development of civilization favours the development of the organization and the increase in profits achieved and facilitates functioning, and new technologies regularly adapt to the needs and influence economic development because effective management can determine success in the organization (Bauman, 2000, p. 5). Modern technologies provide many new opportunities for effective, innovative and more efficient operation of enterprises, increasing the effectiveness of services provided and the number of product offers. However, with such dynamic development, information security must be taken into account. The ongoing changes in the management of organizations mean that personal data is becoming a kind of modern currency and it is very easy to lose it or leak it.

The autonomy of modern technology or its improper use may reduce safety. Technology users often do not protect their personal data or that of other people whose data they process. This may result from ignorance, intentional action or the desire to achieve convenience over the loss of privacy. That is why it is so important to create appropriate regulations, procedures, conduct training and build appropriate security measures.

Modern technologies that ensure organizational security include, for example:

- working time monitoring systems,
- technologies that provide Internet services for organizations,
- identity verification systems,
- e-mail monitoring,
- monitoring of websites viewed by the employee,
- monitoring of the software used,
- access cards to specific rooms,
- access keys to the processed data.

The need for security is one of the most important issues for both individuals and entire organizations. Therefore, modern organizational management requires proper management of information security and personal data. For this purpose, each organization, regardless of whether it is a data controller or a processor, must appoint a personal data inspector who will supervise the accuracy of the processed data.

The most direct use of knowledge and modern technologies for security includes support in making current decisions that improve security, as well as consistent actions related to data integrity violations. The latest knowledge and modern technologies are a key factor in the organization's security level and the fundamental importance of implemented security strategies. That is why it is so important to use the potential of the mentioned factors in practice. Modern technologies, while knowing them properly, currently concern all aspects of security that organizations face every day (Kleiber, 2014, p. 61).

More and more important information is collected on various types of digital media and processed on a large scale. Providing them with the appropriate level of security requires the organization to take multi-directional actions to protect data against modification, loss or theft. However, the multidimensionality of activities must concern all factors that threaten the data, i.e.: human factors (staff), organizational factors (organizational structure), technical factors (technologies used, communication means and software) and emergency factors (unexpected, such as fire, flood). Although it is worth mentioning that, unfortunately, many crimes are committed using IT tools and methods.

The dynamics of organizational development in other parts of the world necessitates the need to constantly modernize technologies and adapt them to constantly emerging new threats. Today, it is difficult to imagine a modern, well-organized and safe organization without the use of modern technologies. The use of information technology in running a company has a positive

impact on innovation, but creates completely new threats. Undoubtedly, modern technologies influence safety, but not always by improving it, but also by reducing it. However, they allow for the ability to prevent threats, not just react to them. Technologies provide the opportunity to address all types of risks related to information integrity. It is not only about solving existing problems, but also about taking a broader look at security in order to reduce the risk.

Therefore, if an organization approaches modern technologies rationally and does not threaten its own safety and the safety of its stakeholders, it can derive many benefits from modern methods, systems and management techniques. New technologies, despite creating many threats, are still being improved and implemented. They help create the future reality, improve the quality of life and increase the security of the organization, but unfortunately, at the same time creating a space of action for people who threaten the processed data.

#### **4. Research methodology**

The aim of the study is to identify threats that may occur when using information technologies in the context of personal data protection; determining which of these threats pose the greatest threat to personal data processed in the analysed organizations and identifying technological factors that influence the increase in the level of security in the context of personal data protection. The study also analyses the number of information security management system certificates according to the ISO 27001 standard, taking into account individual sectors.

Research questions:

- What types of threats may occur when using information technologies in the context of personal data protection and which of these threats pose the greatest threat to personal data processed in the analysed organizations?
- What technological factors (information technologies) influence the increase in the level of security in the context of data protection?

The research used a diagnostic survey method using a questionnaire, which was addressed to personal data protection inspectors and personal data administrators as well as people with knowledge in the field of personal data protection in all Polish local government units processing personal data.

The target population of local government units included 2807 entities, consisting of municipal governments (2477), district governments (314) and voivodeship governments (16). The minimum sample size with a known population size – 2807, maximum allowable estimation error – 5% and confidence coefficient – 95% was estimated at 338 units according to the formula:

$$n_{min} = \frac{p(1-p)}{\frac{d^2}{z_{1-\frac{\alpha}{2}}^2} + \frac{p(1-p)}{N}}, \quad (1)$$

where:

$p$  – estimated fraction size,

$d$  – maximum allowable estimation error,

$N$  – size of the general population,

$z_{1-\frac{\alpha}{2}}$  – quantile of the  $1 - \frac{\alpha}{2}$  order in a standardized distribution  $N(0,1)$ .

Ultimately, in the study carried out for the purposes of the doctoral dissertation, the survey was sent to 372 local government units representing municipal, district and voivodeship governments in all voivodeships. It was taken into account that in order to maintain representativeness, the structure of the research sample according to the voivodeship and the type of local government unit should largely correspond to the structure of the entire population.

The study involved 177 women, representing 47.6% of respondents, and 195 men, representing 52.4% of respondents.

The majority of respondents were people between 41-50 years old (35.5% of respondents) and 31-40 years old (32.5% of respondents). The youngest group consisted of respondents under 20 years of age (0.03% of respondents), which is also the smallest group. The oldest group were people over 50 years old (23.1% of respondents), and the group between 20-30 years old (8.6%).

Most respondents responded from local government units operating in rural areas, which constituted 170 local government units (45.7%). A city under 20,000 inhabitants (small town) was represented by 108 local government units (29%), a city with 20-99.9 thousand inhabitants (medium-sized city) was represented by 72 local government units (19.4%), a city over 200,000 (big city) inhabitants by 12 local government units (3.2%). The smallest group consisted of representatives from a city of 100-199.9 thousand inhabitants (big city) by 10 local government units (2.7%).

## 5. Findings

In the study, factor loadings were calculated using the principal components method with the Varimax rotation. Table 1 includes only significant factor loadings, after rounding, in absolute value not less than 0.7 (Table 1).

**Table 1.**

*Factor loadings obtained using the principal components method after the Varimax rotation in the analysis of the most important technological factor influencing the improvement of the systemic approach and increasing the level of security in the context of data protection in local government units*

Type of technology	Component		
	1	2	3
Website monitoring	0.837		
Monitoring of IT systems and software used	0.828		
Access cards	0.755		
Identity verification for access control	0.752		
Monitoring of e-mail IT systems	0.736		
Monitoring systems for entrances to specific rooms			
Devices, applications and platforms using the Internet of Things		0.812	
Technologies implementing Internet services		0.769	
Employee working time monitoring systems			
Profiling systems			
Settlement and recording systems			
Systems for reporting irregularities (related to, e.g., corruption)			
Computing cloud			
Video surveillance			
Fingerprint readers			0.804
Biometric gateways (facial recognition system)			0.794

Source: own study.

Finally, in order to interpret common factors, variables that were correlated with individual factors were separated. The “Website monitoring”, “Monitoring of IT systems of the software used”, “Access cards”, “Identity verification for access control” and “Monitoring of e-mail IT systems” variables have high factor loadings (0.837, 0.828, 0.755, 0.752 and 0.736, respectively) with the first factor. The “Devices, applications and platforms using the Internet of Things” and „Technologies implementing Internet services” variables have high factor loadings (0.812 and 0.769, respectively) with the second factor. In turn, the “Fingerprint readers” and “biometric gateways” variables have high factor loadings (0.804 and 0.794, respectively) with the third factor.

The first of the distinguished technological factors influencing the improvement of the systemic approach and increasing the level of security in the context of data protection in local government units is therefore described by five important IT solutions:

- website monitoring,
- monitoring of IT systems of the software used,
- access cards,
- identity verification for access control,
- monitoring of e-mail IT systems.

Due to the variables that describe it, it has been defined as “IT monitoring”. The share of this factor in the total variance of the variables included in the study was 28.4%.

The second of these factors is described by two IT solutions:

- devices, applications and platforms using the Internet of Things,
- technologies providing Internet services (e.g., e-mail, social media).

The share of this factor in the total variance of the variables included in the study was 28.1% and was defined as “Internet services technology and the Internet of Things”.

The last factor was also described by two elements:

- fingerprint readers,
- biometric gateways (face recognition system).

and was defined as “Biometric security”. The share of this factor in the total variance of the variables included in the study was nearly 17%.

## 6. Summary

An appropriate management system promotes the proper implementation of processes carried out in private and public organizations. In order to improve and develop the organization and operational effectiveness, it is recommended to implement international standards also in terms of the security of processed information. This also applies to local government units, where the amounts of data processed are huge. The security of data processed in local government units is paramount to the implementation of administrative activities in connection with access to the data of all residents of municipalities, poviats and voivodeships, where unfortunately data leakage or theft also occur. The popularity of implementing systems according to international standards is increasing, both in the area of quality, corporate social responsibility and the above-mentioned information security. Which is why it is so important to conduct risk analyses that take into account threats to the security of processed data in order to eliminate risks or turn them into opportunities for further development of the organization.

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## THREATS OF USING INFORMATION TECHNOLOGY IN THE CONTEXT OF PERSONAL DATA SECURITY

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**Purpose:** The article presents security aspects and its essence in the context of personal data protection. Additionally, attention was paid to the use of new technologies and factors generating threats to the use of the mentioned technology in local government units were identified.

**Design/methodology/approach:** The analysis carried out includes fragments of the doctoral thesis and the results of research carried out within the research topic “Determinants of improving the organization’s strategy in the aspect of business continuity management” research task no. II.2.5, War Studies University. The analysis allowed to verify the factors affecting personal data and to identify the causes of potential threats to this data.

**Findings:** The article identifies factors affecting security and assesses the degree of risk of factors (risk categories) in the context of personal data in the indicated research group.

**Practical implications:** The research indicates fundamental aspects regarding the essence and importance of security and the importance of topics related to the protection of personal data. Additionally, the presented results classify risk categories according to their importance for personal data.

**Originality/value:** The information contained in the article discusses the importance of personal data in the world dominated by technology.

**Keywords:** security, information technology, personal data protection, human resources, information security management system.

**Category of the paper:** research and review publication.

### 1. Introduction

Proper protection of personal data plays a key role in the security of IT systems in relations to the functioning of local government units due to the large amount of data processed in their structures using information technology.

Due to the obligation to secure information resources, local government units are obliged to take a number of actions regarding the processed data. These activities should include activities of a human, organizational, technical and technological nature, as well as those resulting from sudden and unexpected events. When performing public tasks, local government units must also ensure public security, i.e. *a state within the country based on legal norms, in which conditions are ensured for the efficient functioning of a state organization pursuing common, supra-individual goals, obligations are effectively enforced and the rights of individuals living in this organization are protected...* (Fehler, 2010, p. 31).

## 2. Security, essence and importance

The term security, used to define a state of peace, a state of certainty, i.e. the absence of threats, expresses a subjective nature. However, it is one of the most basic human needs, the satisfaction of which activates higher-level needs. In his theory of motivation, A. Maslow distinguishes safety as the second human need in the hierarchy.

In the most general sense, security is a state in which there are no threats (Żurkowska, 2006, p. 21). M. Lasoń adds that it is a state of peace, certainty of protection against dangers and the ability to defend against them (Lasoń, 2010, p. 9). Nowadays, security is supposed to satisfy human happiness in a holistic sense. It is the paramount necessity and need of all people (Tulibacki, 1999, p. 33). There is no doubt that it is considered one of the basic needs of humans, as well as social groups, the nation and the state (Czuryk et al., 2016, p. 17).

J. Kaczmarek and A. Skowroński drew attention to the etymology of the word security, which comes from the Latin *securitas*. This word, consisting of two elements “sine” meaning “without” and “cura” meaning “care”, defines a state characterized by the absence of worries and the unpleasant feeling of fear (Kaczmarek et al., 1998, p. 17).

The semantic evolution of the word security meant that initially the word meant without concern, without care. Then this meaning changed, shaping its meaning into the statement of being self-confident and brave. Which, in consequence, led to a change in the meaning of the word, from the meaning of without care, without upkeep to not threatened and not threatening. In the Polish language, this was caused by the semantic expansion of the antonym of the word “pieczy” (care) as “niebezpieczny” (dangerous). In the first half of the 14<sup>th</sup> century, the word opposite to without concern was used with the negation of not or being without concern for existence, for being, i.e. being anxious, feeling insecure. Consequently, the antonym of danger meant free from danger. Therefore, until the end of the 19<sup>th</sup> century, the word safe meant unthreatened, unthreatening, brave, self-confident (Dominiak, 2007, pp. 192-196).

The multi-aspect nature of security means that this word is defined in various ways, both in Polish and foreign literature. L.F. Korzeniowski defines security as “the objective state of an entity, consisting in the absence of threats, where this state is felt subjectively by individuals and groups” (Korzeniowski, 2012, p. 76). According to P. Gasparski, “security and survival are the most important, cardinal principles of life. Without taking care of security, neither the individual nor the community could exist”, lead a life limited to meeting basic needs. The author suggests that avoiding threats is a basic survival mechanism, treating safety as one of the basic human values, where neglect of safety may suggest a kind of departure from the norm” (Gasparski, 2003, pp. 159-160).

P.D. Williams, in a textbook on security, expresses the opinion that this word is multi-aspected, both ontologically, epistemologically and methodologically. Therefore, security can be treated as a state of control over everything that poses a threat to the values valued by people. This especially applies to threats that, if unattended, could affect the survival of individual entities (Williams, 2008, p. 5).

According to R. Zięba, when deciding about an individual as an inherent subject of the collective, and at the same time the subject and dispenser of the security credo, it can be concluded that *security is the certainty of existence and survival, functioning, development and possession of the entity. The certainty of existence results both from the lack of threats and as a result of the entity's daily activities; it has the nature of a social process, i.e. it changes over time* (Zięba, 2008, p. 16). The author of this definition combines both the aspects of the state and the process, treating security as the activity of an entity in which the state and sense of security are the result.

J. Świniarski also started to create a definition of security, concluding that *any form of a chosen state of affairs is safe when there is a chance for development and improvement in the perspective of its extension. This perspective depends on both threats and favourable circumstances to counteract, avoid, eliminate, remove or overcome these threats* (Świniarski, 1997, p. 174). The author also notes that this does not only concern threats or their lack, but also on approach that creates opportunities and leads to a longer feeling of security.

*Security as a social fact* (Moczuk, 2009, p. 70) is defined by E. Moczuk. According to the author, this concept indicates a social system of behaviour of individuals that allows the survival of a specific individual and the entire community, depriving them of the possibility of fear of loss of life, health, statehood, nationality, property, religion, value system and other elements related to a comprehensive understanding of safety, as well as anxiety that these fears will cause fears in others (Moczuk, 2009, p. 70). The mentioned social system of behaviour indicates both the vision of one's own person, i.e. the individual's identity, as well as living conditions ensuring a high standard of life and a sense of satisfaction in the cultural sphere.

### 3. Information security in the context of personal data protection

Information security is often perceived as part of the IT system. Calling it network security, computer security, telecommunications security, data security, etc. (Janczak, Nowak, 2013, p. 17).

Information security includes elements of information security and ICT security, i.e. IT security (systems) and ICT network security. Information security is the protection of all forms of data exchange, storage and processing. ICT security is limited to technical ICT means, ICT systems, computer systems (IT security) and ICT networks (ICT network security) used to exchange, store and process data in electronic form (Janczak, Nowak, 2013, p. 17).

IT security is therefore the security of communications, and IT security defines the security rules defined for the software and hardware of a computer system to protect against manipulation, disclosure, deletion, data modification or denial of service (Janczak, Nowak, 2013, p. 45).

According to the Personal Data Protection Office and the PN-ISO/IEC 27000 standard, personal data security is information security supervision, i.e. a system through which the functioning of an organization (its activities) in the field of information security is controlled and directed.

The enormous progress of civilization, which has brought transformations in the management of organizations, has caused these organizations to transform, make changes and adapt to new standards. This applies to both the civil economy as well as organizations and institutions operating in the area of security management. Undoubtedly, the most important factor causing changes is the technological factor. Technology means a field of technology that deals with the design and modelling of new production methods or methods of processing raw materials. Thus, new technologies mean the use of the latest results resulting from knowledge of science in connection with conducted research and their application in practice.

It is worth noting that currently virtually all organizations undertake activities aimed at supporting management processes. These processes mainly concern the improvement and streamlining of management in the area of logistics, finance and human resources, where the use of modern IT solutions facilitates rational management (Kuck, 2012, p. 186).

The use of modern technologies in management is applicable both from a strategic and operational perspective. The essence and role of technology is of great importance in modern and innovative management, where knowledge of the potential of technology and its impact on creating competitive advantages, building business models as a tool for competing in an enterprise enables management in diverse economic conditions.

Organizations that support technology and digitalization result in positive economic growth, meet the expectations of contractors and achieve higher profits. However, those using old management models are often doomed to failure. The development of technology very often

precedes other economic sectors and concepts in the field of social sciences, yet politics and law should support the development of technology. Therefore, it is worth investing in technologies, digital business and an environment that will constantly develop in this aspect.

New technologies used in the economic market are very often combined with information technology (IT), which allows the processing of information between devices and users of these devices. Additionally, it stores and secures the acquired information for later analysis and presentation, so that the right information can be delivered to all interested parties. Fast and reliable access to information is a huge advantage of enterprises that process data at the right time, at the right decision-making level and at the same time ensuring the required level of security. In this aspect, it seems necessary to use modern information technologies that enable the exchange of all types of data through computer networks of specific organizations.

Modern technologies support management processes, enable efficient management of projects implemented in organizations, provide necessary information, secure the organization's financial resources and provide the opportunity to exchange experiences. Additionally, they facilitate the implementation of purchases made by the organization, provide the opportunity to prepare and conduct training for employees on, for example, personal data protection, which are aimed at improving the security of processed information and facilitate human resources management. New technologies are also the Internet of Things, very often used in the main sectors of the national economy: trade, transport, industry, science, education, health care, administration and agriculture, providing the opportunity to integrate the systems of manufacturers and recipients.

New technologies in organization management allow for the identification of ongoing projects, determining the necessary resources indicating the correctness of performing a specific task, and provide the opportunity to search for optimal ways of implementing activities. They create a system for managing the security of processed information, ensuring information security and ICT security, while ensuring continuous availability, confidentiality, integrity and resilience of services and systems used for data processing.

The basis for proper management of an organization in the era of modern technologies is the appropriate use of IT systems, which become their integral part. The construction of an appropriate management system should be based on the development and implementation of an informatization strategy, i.e. the appropriate relationship between people, resources (including technological ones) and management methods enabling the achievement of intended goals within a specified period of time. This concerns the following elements (Kuck, 2012, p. 188):

- the current state of computerization for the organization,
- direction of development of computerization,
- basics of an IT system to support specific processes,
- the effects of computerization and the strategic goals of the organization.

Modern technologies in organizational management should only be limited to improving the quality of enterprise functioning and having a positive impact on the information security management system (ISMS), which is the basis for the functioning of organizations dominated by modern technologies. This system integrates with other systems supporting the functioning of the ISMS (Wołowski, Zawila, Niedźwiecka, 2012, p. 17). In a world dominated by technology and big data analytics, the importance of an information security management system stems from the validity of personal data protection regulations of all organizations processing data (both customers and employees).

#### 4. Research methodology

The aim of the study is to identify threats that may occur when using information technologies in the context of personal data protection; determining which of these threats pose the greatest threat to personal data processed in the analysed organizations and identifying technological factors that influence the increase in the level of security in the context of personal data protection.

The research used a diagnostic survey method using a questionnaire, which was addressed to personal data protection inspectors and personal data administrators as well as people with knowledge in the field of personal data protection in all Polish local government units processing personal data.

The target population of local government units included 2807 entities, consisting of municipal governments (2477), district governments (314)<sup>1</sup> and voivodeship governments (16). The minimum sample size with a known population size – 2,807, maximum allowable estimation error – 5% and confidence coefficient – 95% was estimated at 338 units according to the formula:

$$n_{min} = \frac{p(1-p)}{\frac{d^2}{z_{1-\frac{\alpha}{2}}^2} + \frac{p(1-p)}{N}}$$

where:

$p$  – estimated fraction size,

$d$  – maximum allowable estimation error,

$N$  – size of the general population,

$z_{1-\frac{\alpha}{2}}$  – quantile of the  $1 - \frac{\alpha}{2}$  order in a standardized normal distribution  $N(0,1)$ .

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<sup>1</sup>Cities with country rights are included in the municipal government.

Ultimately, in the study carried out for the purposes of the doctoral dissertation, the survey was sent to 372 local government units representing municipal, district and provincial governments in all voivodeships. It was taken into account that in order to maintain representativeness, the structure of the research sample according to the voivodeship and the type of local government unit should largely correspond to the structure of the entire population.

The study involved 177 women, representing 47.6% of respondents, and 195 men, representing 52.4% of respondents.

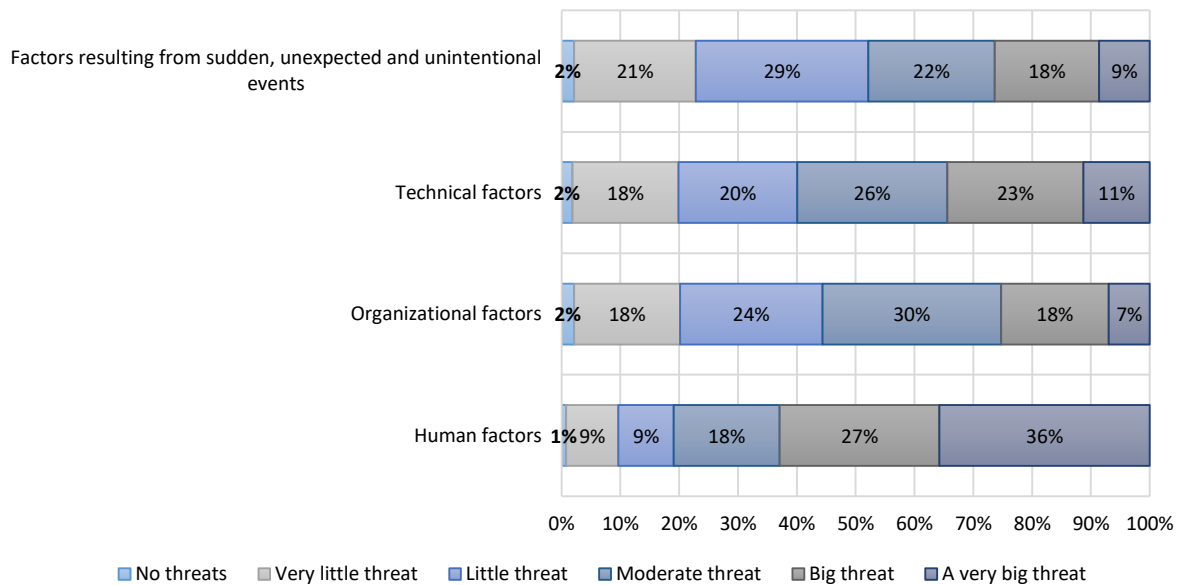
The majority of respondents were people between 41-50 years old (35.5% of respondents) and 31-40 years old (32.5% of respondents). The youngest group consisted of respondents under 20 years of age (0.03% of respondents), which is also the smallest group. The oldest group were people over 50 years old (23.1% of respondents), and the group was between 20-30 years old (8.6%).

Most respondents responded from local government units operating in rural areas, which constituted 170 local government units (45.7%). A city under 20,000 inhabitants (small town) was represented by 108 local government units (29%), a city of 20-99.9 thousand inhabitants (medium-sized city) was represented by 72 local government units (19.4%), a city with over 200,000 inhabitants (large city) by 12 local government units (3.2%). The smallest group were representatives from the city of 100-199.9 thousand inhabitants (large city) by 10 local government units (2.7%).

#### **4.1. Research Findings**

The conducted research allowed for the identification of factors that generate threats in the context of personal data protection in local government units.

As can be seen in Fig. 1, according to the surveyed local government units, the human factor resulting from the possibility of accidental, unintentional disclosure of personal data is a key risk category that may have a negative impact on the personal data protection process. Analysis of this chart shows that 63% of entities considered this factor to be at least a major threat to the functioning of local government units, with the majority of them defining this risk category as a very major threat. Only 1% of individuals considered that the human factor does not constitute any threat from the point of view of personal data protection, and 18% consider it to be at most a small threat.



**Figure 1.** Distribution of answers to the question what factors (risk categories) pose the most threats in the context of personal data protection in local government units.

Source: own study based on conducted research.

In the context of other risk categories that may have a negative impact on the personal data protection process, it can be noted that they generally pose a moderate threat at most. This applies to both organizational factors (resulting from the adopted organizational structure, applied technical and technological solutions), technical factors (resulting from the adopted methods of securing rooms, operating devices, the method of organizing exits and entries to rooms and buildings, closing cabinets, rooms and other places) as well as those resulting from sudden, unexpected or unintentional events.

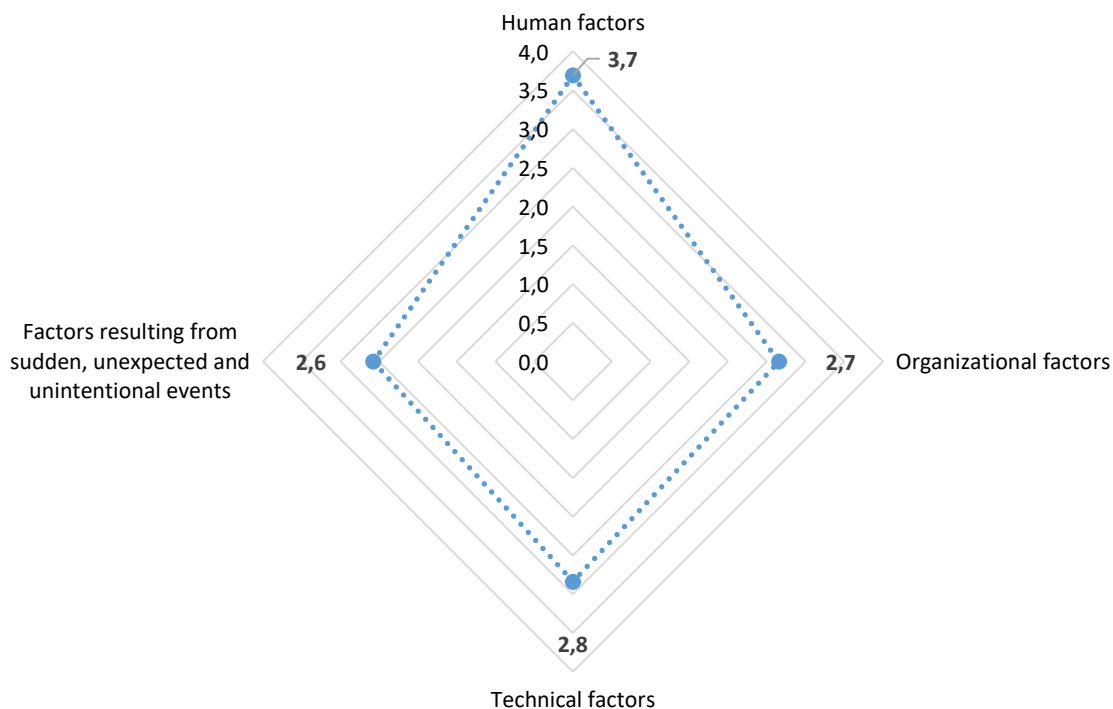
34% of local government units consider technical factors to be at least a major threat. In the case of factors resulting from sudden, unexpected and involuntary events and organizational factors, only 27% and 25% of individuals respectively consider them a risk category of at least a high risk in the context of personal data protection. With regard to factors resulting from sudden, unexpected and no-fault events, technical and organizational factors, local government units usually considered them to be risk categories carrying low risk (no threat, very low risk and low risk). Respectively, 52%, 40% and 44% of the surveyed units indicated this level of threat.

The above observations are confirmed by the assessment of the degree of risk of factors (risk categories) in the context of personal data protection in local government units, expressed as an arithmetic mean<sup>2</sup>.

<sup>2</sup> The following coding method was adopted: 0 – no threat, 1 – very little threat, 2 – little threat, 3 – moderate threat, 4 – high threat and 5 – very high threat.



Of all four key factors that pose a threat to local government units from the point of view of personal data protection, the human factor turned out to be the most important. This is evidenced by the high value of the average, which is a measure of the assessment of the degree of threat, which was 3.7 for this risk category. It is worth mentioning that for the human factor, the dominant response was 5 and the median was 4. This means that local government units most often considered the human factor to be a very high risk in the context of personal data protection, and 50% of them considered it to be at least a major threat. For the remaining risk categories considered (factors resulting from sudden, unexpected, no-fault events, organizational and technical factors), the risk level expressed as an average was at the level of 2.6-2.8.



**Figure 2.** Assessment of the degree of risk of factors (risk categories) in the context of personal data protection in local government units.

Source: own study based on conducted research.

It is worth emphasizing that for organizational and technical factors, the dominant was 3 (moderate threat), as was the median – 3. In the context of factors resulting from sudden, unexpected and involuntary events, the dominant and the median were even smaller and amounted to 2 (low threat).

The conducted research made it possible to isolate the most important technological factors (information technologies) influencing the improvement of the systemic approach and increasing the level of security in the context of data protection in local government units. For the purposes of the study, exploratory factor analysis was used once again.

The factor extraction process began with assessing the significance of the correlation matrix. For this purpose, the Barlett's test of sphericity was used, which is one of the tools used to assess the validity of using factor analysis. The p-value determined in Barlett's test of sphericity was 0.000<sup>3</sup> and is lower than the significance level adopted for the analysis  $\alpha = 0,05$ . The null hypothesis that all correlation coefficients are equal to zero should therefore be rejected. The adequacy of the correlation matrix was then assessed using the Kaiser-Mayer-Olkin (KMO) coefficient. The degree of adequacy measured by the KMO coefficient was 0.94. We therefore have a strong basis for using factor analysis. Further in the study, the main factors of information technology that influence the improvement of the systemic approach and increase the level of security in the context of data protection in local government units were identified. For this purpose, the principal components method with Varimax factor rotation was used to determine the factors.

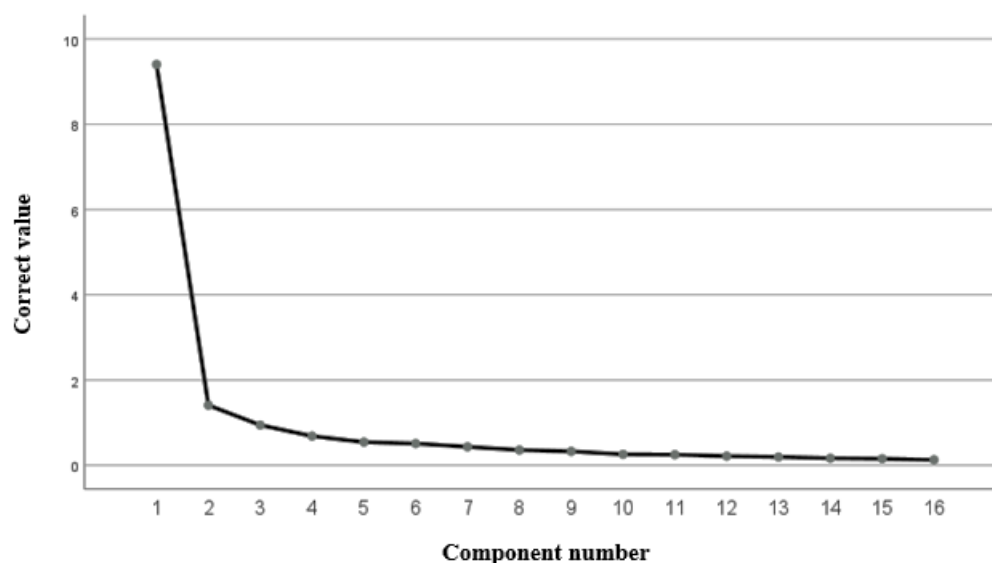
First, the number of factors was determined. For this purpose, the halfway criterion and the scree criterion were used, according to which we are looking for a place from which there will be a gentle decline in eigenvalues to the right, i.e. a place from which the so-called "factorial scree" is located to the right. By analysing figure 3 it can be seen that the "scree" phenomenon most likely occurs with the second or third factor. To the right of this place there is a slight decline in eigenvalues.

In the process of isolating the main information technology factors that influence the improvement of the systemic approach and increase the level of security in the context of data protection in local government units, it was finally decided to select three main factors that allow to explain approximately 73% of the total variability (Table 1). According to the so-called half criterion it is also a sufficient number of factors that can be subject to substantive assessment<sup>4</sup>.

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<sup>3</sup> For the purposes of the analysis, it was rounded to three decimal places.

<sup>4</sup> According to the half criterion, it is enough to isolate enough factors to explain at least 50% of the total variability. Therefore, the analysis could include two factors based only on this criterion. However, based on the scree and half criteria, it was considered more rational to take into account three factors that explain much more variability than two factors.



**Figure 3.** The scree plot in the analysis of the most important technological factors influencing the improvement of the systemic approach and increasing the level of security in the context of data protection in local government units.

Source: own study based on conducted research.

**Table 1.**

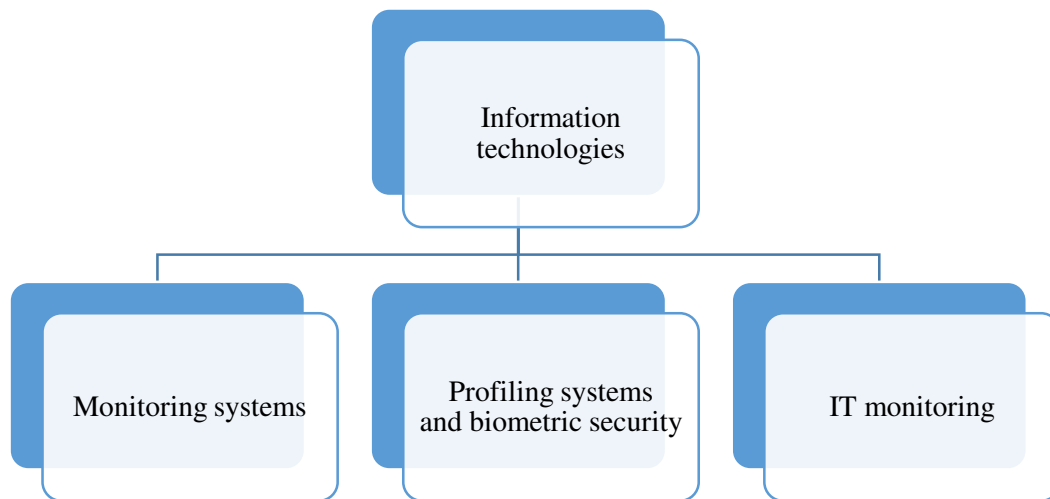
*Total explained variance in the analysis of the most important technological factors (information technologies) influencing the improvement of the systemic approach and increasing the level of security in the context of data protection in local government units*

Component	Total	% variance	% cumulative
1	4.549	28.430	28.430
2	4.493	28.079	56.509
3	2.717	16.982	73.491

Source: own study based on conducted research.

The factor corresponding to the first (largest) eigenvalue explains approximately 28.4% of the total variance, the second component explains approximately 28.1% of the total variance and the last third component explains approximately 17% of the total variance. Taking into account the scree and half criteria, three factors were finally identified, which explain a total of 73% of the total variance.

When summarizing the analysis performed, it can be noted that there are three key factors (groups) of information technologies that influence the improvement of the systemic approach and increase the level of security in the context of data protection in local government units (Figure 4).



**Figure 4.** Information technologies influencing the improvement of the systemic approach and increasing the level of security in the context of data protection in local government units.

Source: own study based on conducted research.

Therefore, local government units recognize the need to use modern solutions in the field of information technology to maximize the degree of protection of individual data, while minimizing the risk of their disclosure to third parties. However, they are aware that their development, especially in relation to IT monitoring and biometric security, may also constitute a source of threat to the security of personal data. This may be due to the fact that, on the one hand, local government units see great potential and the need to improve technological solutions in the context of personal data protection, and at the same time they notice certain threats that this development creates (the development of technology generates gaps in the data protection system, the applicable regulations are not adequate to the current state of new technologies).

## 4.2. Discussion

Summarizing the analysis carried out, it can be clearly stated that the factor limiting the effectiveness of personal data protection using information technology is humans. Local government units consider the human factor to be crucial and likely to pose the greatest threat in the context of personal data protection.

In the literature, the most common causes of potential threats are mentioned (Bógdał-Brzezińska, 2012, p. 7):

- improper protection of services, cryptographic devices and auxiliary devices,
- damage to devices and/or telecommunications lines,
- inappropriate or insufficient software,
- gaps and errors causing data loss,
- lack of user awareness of IT security, validity of processed data, possibilities of personal data protection, expected penalties related to violations, etc.,
- intentional damage to IT systems,
- intentional attacks,

- short technology life,
- conscious incidents committed by users (managerial staff, employees), e.g. connecting devices to an unsecured network or connecting external devices containing malicious software,
- unauthorized actions of administrators and/or users.

M. Soczko takes into account the following threats based on the frequency of incidents (Soczko, 110):

- disclosing personal data to unauthorized persons,
- inability to access personal data by authorized persons,
- destruction, damage or alteration of personal data,
- operation of malicious software (keyloggers, viruses, Trojans, etc.),
- intrusion of an unauthorized person into the data processing area,
- social engineering attacks,
- attempts to extort data and/or data security methods,
- loss, damage or theft of media, backup copies and devices containing data.

As K. D. Mitnick and W.L. Simon note in their book, despite purchasing the most expensive and best security technologies, using services that protect the organization, the training employees in terms of confidentiality of the acquired data, the organization still remains unsecured. Similarly with private persons. They can implement all kinds of rules that are recommended by experts, configure the system, install security programs, use all kinds of permissions and also remain unsecured. The authors note that the Achilles heel of security systems is the human factor. Security, through people's naivety, ignorance, recklessness, or gullibility, often becomes an illusion (Mitnick, Simon, 2003, p. 24).

## 5. Summary

Changes taking place in the modern world have made information technology play a huge role in human functioning, and personal data have become a kind of modern currency. It is very easy to lose or leak personal data, it is an irreversible process, which is why it is so important to comply with the provisions on the protection of personal data and to promote the code of good practices in the use of information technologies in the context of personal data protection.

Personal data protection regulations in local government units are often unknown or known only to a small or moderate extent. However, it is worth realizing that the processing of data by persons who do not have appropriate knowledge in the field of personal data protection does not guarantee their protection and security of processing.

In order to improve the quality of the management process and minimize the risk of threats to personal data security resulting from the use of information technologies, a comprehensive approach is proposed by implementing and certifying an information security management system.

Statistics show that despite the growing number of certificates granted for compliance with the ISO 27001 standard worldwide, the share of certificates granted in the Public administration sector is relatively small compared to other sectors.

Therefore, it is recommended to pay attention to the establishment, implementation, operation, monitoring, review, maintenance and improvement of the Information Security Management System, because a properly implemented and certified system brings many benefits to the organization that contribute to improving the quality of management and increasing the organization's security level.

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## ESG STANDARD AS A STRATEGIC DETERMINANT OF BUILDING ORGANIZATIONAL RESILIENCE

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**Purpose:** The paper aims to present the ESG standard as a determinant contributing to building organizational resilience

**Design/methodology/approach:** To achieve the assumed goal, the paper applies a comprehensive review of Polish and foreign publications, with the use of the Web of Science and Scopus databases. The desk research analysis is based on data obtained from BNP Paribas publications, the "Risk Resilience" Report, the EY "Sustainable Value Research 2023" Report and the "Global Sustainable Investment Review".

**Findings:** The result of the research is the presentation of the draft ESG standard, which will be reported by enterprises in accordance with the EU CSRD. The presented content is illustrated by the perception of requirements related to sustainable development (ESG) by managers in Poland and in global corporations.

**Research limitations/implications:** The presented findings constitute an inspiration for further research, especially to seek answers to the question concerning the actual achievements of Polish enterprises in ESG areas.

**Practical implications:** The analysis and assessment of reporting in accordance with the ESG standard allows for specifying which areas of enterprise activity are affected by new requirements and what are the motives of managers when implementing sustainable development goals.

**Social implications:** The analysis and assessment of reporting consistent with the ESG standard should contribute to expanding the information base for various groups of internal and external stakeholders on the implementation of the concept of sustainable development and building the company's resilience.

**Originality/value:** The paper synthetically presents the increasingly important and urgent need to consider the ESG standard in connection with building the resilience of entities operating in the Polish and international arena.

**Keywords:** ESG, organizational resilience.

**Category of the paper:** General review.

## 1. Introduction

Enterprises are increasingly often forced to quickly and strategically respond to various types of changes, including political, technological as well as social, epidemic and ecological changes, which have become especially noticeable in recent years. Several types of turbulences and concerns are observed in the local and national environment, as well as on a global scale, which induces an increasing level of uncertainty. Such circumstances of enterprise operations require increased flexibility in various aspects of business activity to adapt and transform to rapidly changing external and internal conditions (Branicki, Steyer, Sullivan-Taylor, 2016; Linnenluecke, 2015; Witmer, Mellinger, 2016). This approach means building resilience, which requires transformation and flexibility at the individual and team level, in conditions of various market turbulences and discontinuities, in order to achieve a competitive advantage (Goncalvesi, Ribeiro 2019; Sharma et al., 2020).

The idea of sustainable development, i.e., development that meets the current needs of people without limiting the ability of future generations to meet their needs is the concept that now significantly determines the functioning of economic organizations. Sustainable development requires a joint effort to build a sustainable and disaster-resilient future for all people in the world. To achieve sustainable development, coherence of three key elements including economic growth, social inclusion and environmental protection is necessary. They are interconnected and extremely important for achieving benefits both for specific enterprises and their stakeholders, but also for the well-being of individuals, local communities and entire societies.

The ESG standard (an acronym for environment, social, governance) is an emanation of the concept of sustainable development. Various stakeholder groups are urging companies to take concrete and transparent actions on ESG issues. They are looking for business organizations that operate on the basis of a specific mission and care about areas that are important from the point of view of employees, communities, industries and the entire world. They value the transparency that the digital age provides them and are willing to invest money in initiatives that are consistent with their beliefs.

On the other hand, companies that include ESG-related requirements in their activities gain the opportunity to change their current approach, contribute to better respect for human rights, protect the environment and create new business value. Board members and senior management staff who are able to implement ESG disclosure principles are well on their way to building a business that skillfully integrates ESG elements into its strategic plans and is better prepared to manage risk, while the same time ensuring sustained value for stakeholders and increasing resilience of the company in the world driven by new rules.

The paper aims to present the ESG standard as a determinant contributing to building organizational resilience. It is not only about adapting to the requirements of the European Union CSRD and reporting requirements under ESRE, but entering a new level of development in which the ESG standard will become part of the genetic code of every enterprise.

The paper applies a comprehensive review of Polish and foreign publications with the use of the Web of Science and Scopus databases. Meanwhile, the desk research analysis is based on data obtained from BNP Paribas publications, the "Risk Resilience" Report, the EY "Sustainable Value Research 2023" Report and the "Global Sustainable Investment Review".

## **2. Organizational resilience – diversity of approaches**

It is a kind of truism to say that it is difficult to present a single, universally acceptable definition of organizational resilience. This concept is found in the literature in many contexts, in a broad range of research areas, including environmental sciences, psychology, urban planning and organizational management sciences. Considering the latter, organizational resilience shifts the focus from an individual to a systemic perspective. From this perspective, organizational resilience studies power structures, processes, as well as collective social interactions in an organizational context under conditions of high stress. Organizational resilience refers to an organization's ability to respond productively to significant destructive changes, especially unexpected, emerging events (Witmer, Mellinger, 2016). From the systemic perspective, organizational resilience is based on mutual and symbiotic relationships within the organizational system and between the system and its environment (Bhamra, Dani, Burnard, 2011; Linnenluecke, 2015).

The first studies on resilience in the context of organizations focused primarily on crisis and the way in which an organization responded to a single disaster, both from the perspective of the organization's relationship with its environment and the individual psychological reactions of organization members (Branicki, Steyer, Sullivan-Taylor, 2016; Limnios et al., 2014). As Bundy states (Bundy et al., 2017), organizational resilience is manifested by the use of crisis management that is the organization's response to phenomena that are difficult to predict; it is a process by which an organization responds to devastating, unforeseen events that threaten or are even harmful to the organization, its employees and other stakeholders. Based on the analysis of a broad range of literature on the subject, it can be concluded that crisis management and organizational resilience have much in common, however knowledge in these areas is currently developing in separate trends (Williams et al., 2017).

A broad approach to organizational resilience is a proactive approach which focuses on continuous preparedness for the unexpected (Burnard, Bhamra, Tsinoopoulos, 2018; Limnios et al., 2014; Witmer, Mellinger, 2016). Resilient organizations have the ability to learn, respond, and adapt to both internal and external turbulences while maintaining their integrity as a system implementing its mission (Witmer, Mellinger, 2016). More recent theoretical frameworks combine various aspects and describe organizational resilience as a complex phenomenon that includes structural, relational, and contextual components, comprising both relational, collaborative, and rational processes in response to unstable and often competitive external conditions (Branicki, Steyer, Sullivan-Taylor, 2016; Burnard, Bhamra, Tsinoopoulos, 2018; Mallak, Yildiz, 2016). Resilience is viewed as a positive state that every organization seeks to achieve in order to be relevant and responsive to current conditions (Limnios et al., 2014). Certainly, the existence of procedures for dealing with crisis situations, describing management techniques and behaviors, is an essential element shaping resilience, but this is not the whole picture of the phenomenon. What escapes attention in this case is the issue of individual resilience, making sense, behavior and emotions, rationalization, changing business models, and the organization's ability to respond to the crisis. Therefore, crisis management should be treated as one of the mechanisms leading to organizational resilience.

Literature derived from multidisciplinary and multifaceted research emphasizes various organizational elements that constitute the basis for building organizational resilience. The selected ones are presented in table 1.

**Table 1.**  
*Organizational contexts related to building its resilience*

Organizational context	Characteristics
Decision-making processes	Decisions regarding changes, transformations and solving current problems are a key element that allows organizations to adapt. When describing the processes of adaptation and creating resilience, Williams et al. (2017) point to decision-making as one of the elements determining the introduction of changes aimed at survival. On the other hand, Van den Berg et al. (2022) emphasize the importance of delegating decision-making powers and positive empowerment, which may be crucial for taking quick and necessary actions in the face of unforeseen crisis situations.
Organization's resources	They are a source and one of the carriers of organizational resilience. Financial resources (Searing, Wiley, Young, 2021) and the so-called slack resources (Aidoo et al., 2021), should be considered vital from the perspective of survival. They facilitate adaptation to new conditions through the possibility of introducing solutions adequate to new market circumstances. Many researchers (Visser, 2021; Webb, Chaffer, 2016; Ngoc et al., 2021) considered human resources to be equally important in building organizational resilience, paying special attention to their competences and the human resources management policy. Finally, modern information technologies used by enterprises are the third group of resources that attract the attention of researchers.
Attributes of individuals	First of all, managers, leaders, owners, main decision-makers and employees (Anwar, Coviello, Rouziou, 2022). Organizational response to a threat may depend on a set of individual characteristics, behavior in unfavorable situations, and attitude. Such features include, for example, narcissism and the tendency to take risks, managers' weaknesses (cognitive errors), optimism, a sense of self-efficacy, anxiety, cognition, emotions and psychological safety, gender, trust, leader resilience, short-term thinking or stress.

Cont. table 1.

Learning and knowledge management	A number of studies highlight the role of learning from events that potentially could bring devastating consequences (Azadegan et al., 2019), and according to Audretsch and Belitski (2021), organizational resilience and knowledge management together can lead to above-average organizational effectiveness. According to Carmeli, Levi and Peccei (2021) access to knowledge and learning from experience promotes creative problem solving in project teams and leads to improvement of its effectiveness as well as increasing the resilience of the organization. In turn, Manab and Aziz (2019) opt for the inclusion of knowledge management in the practice of responsible risk management, which would lead to the survival of the organization.
Change	Building organizational resilience requires implementing actions focused more on transformation rather than just passive adaptation to the existing situation, i.e., accepting the new reality as normal (Clement, Rivera, 2017). In this context, both changes in the very organization as well as digital transformation are emphasized.
Strategy	Weigand et al. (2014) indicate the need to include foresight based on collaboration in long-term strategic planning. Rajala and Jalonon (2022) draw attention to the role of strategic planning as a mechanism that allows for preparing for a crisis or unforeseen difficulties. Strategy can be perceived as a factor supporting resilience, an element of the organization that allows for a conscious, planned and purposeful response to new events in a specified way (Alonso, Bressan, 2015).
Corporate governance	In recent years, threads regarding corporate governance have also occurred in the literature on the subject. Korbi, Ben Slimane, Triki (2021) analyze the processes by which international entities operating in joint ventures build resilience in management and corporate governance processes. In this context, increasing partner engagement and the emergence of transactional leadership are becoming key issues. In turn, Hadjielias, Christofi and Tarba (2022) focus in their considerations on building the resilience of small enterprises in which the owners are also people involved in management.
Organizational ambidexterity	Organizational ambidexterity is a concept that has a lot in common with paradoxes, reconciling contradictions and looking at the past and the future at the same time. Such skills offer managers and organizations the opportunity to learn from previous experiences on the one hand, and on the other, openness to new challenges (Karman, Savaneviciene 2020).
Interorganizational collaboration	The issues of coopetition and interorganizational collaboration discussed in publications indicate their significant role in strengthening the resilience of an enterprise to crisis (Chowdhury et al., 2019).
Corporate social responsibility	The authors of the publication emphasize the importance of stable and responsible business practices (recorded, for example, in ethical codes) for long-term benefits of the organization and fostering the resilience of the entire enterprise (Ortiz-de-Mandojana, Bansal, 2016).

Source: elaborated on (Williams et al., 2017; Van den Berg et al., 2022; Searing, Wiley, Young, 2021; Aidoo et al., 2021; Visser, 2021; Webb, Chaffer, 2016; Ngoc et al., 2021, Anwar, Coviello, Rouziou, 2022, Azadegan et al., 2019, Audretsch, Belitski, 2021, Carmeli, Levi, Peccei, 2021, Manab, Aziz, 2019, Clement, Rivera, 2017, Weigand et al., 2014, Rajala, Jalonon, 2022, Alonso, Bressan, 2015, Korbi, Ben Slimane, Triki, 2021, Hadjielias, Christofi, Tarba, 2022; Karman, Savaneviciene, 2020, Chowdhury et al., 2019; Ortiz-de-Mandojana, Bansal, 2016).

A lot of literature references on the subject especially emphasizes on the reactive and proactive approach to organizational resilience. Bhamra (2015) and Pratono (2022) describe organizational resilience in a reactive way through willingness to take risks, adaptation and return to the pre-crisis state. Reactive organizations seem to be passive in predicting the changing business environment (Granig, Hilgarter, 2020). Meanwhile, according to Holbeche (2018), a proactive approach to resilience is based on flexible team-based structures that enable sharing the learning process across the entire organization. An organization with the ability to develop strategic resilience is capable not only of adaptation, but also of entering a new level of development and ensuring competitive advantage in the future.

### 3. ESG standard

Business conditions are constantly changing. It is difficult to list all the determinants that affect the functioning of modern corporations, but considering recent years, climate change, degradation of the natural environment on a global scale, ecological disasters, the covid-19 pandemic, challenges related to digital transformation, armed conflicts, social unrest, human rights violations, labor rights violations, etc. should be mentioned. In the past, companies created products for consumers who had rather vague knowledge about how businesses were run, the resources consumed, the products used and ultimately disposed of. Today, various entities from around the world, including employees, suppliers, business partners, community members, activists and entire society, are equal participants – the stakeholders - in direct dialogue with the company about what they expect from it. Manifestations of various stakeholder groups' activation include, for example, climate strikes or the #Me Too campaign. There are strong voices that CEOs should be accountable not only to the management board or shareholders, but also to society.

The issue of the functioning of enterprises, going beyond purely business issues, is not an invention of recent years. Since the 1970s, the concept of CSR (*corporate social responsibility*) has been developing. Initially, it emphasized the issues of philanthropy and charity, then the impact of business on employees and local communities began to be highlighted. Blowfield (2005) defines CSR as a management concept in which companies integrate social and environmental issues in their operations and interactions with stakeholders. Increasing awareness of the harmfulness of certain businesses, promoting pro-ecological attitudes and tolerance for diversity is a prominent issue discussed as part of CSR. There are specific areas of corporate social responsibility, including organizational governance, human rights, labor relations, environment, fair market practices, consumer relations, and social involvement. Social campaigns, vocational training programs for disabled people or other groups deprived of civil rights, at risk of social exclusion, commitment to ensure employee diversity based on race, gender and sexual orientation, non-discrimination, recycling, lower energy and water consumption by the organization, more efficient supply chain, promoting the use of public transport or cycling, employee volunteering, direct donations to non-profit organizations, appropriate product labeling, or management systems are the tools most frequently applied to implement CSR in enterprises (e.g. ISO 9000, ISO 14000, SA 8000). It is the weakness of the CSR concept that it is voluntarily implemented in business organizations, and managers communicate the progress in its implementation to stakeholders in a rather free and arbitrary way. As a result, comparing the effects of CSR implementation between different companies is difficult, and sometimes even impossible (Stefańska, 2013). Over time, however, various stakeholder groups, especially investors, began to look for the possibility to compare CSR practices of different companies. This is how ESG emerged.

It refers to three areas enabling the assessment of the company's impact on the environment (E - environmental) and society (S - social) as well as the principles of applying corporate governance (G - governance).

Currently, CSRD (Corporate Sustainability Reporting Directive, 2022/2464/EU) is the central element of the ESG concept. The directive adapts companies' non-financial reporting with the SFRD (Sustainable Finance Disclosure Regulation, 2019/2088/EU), which regulates how financial market participants and financial advisors should disclose information on sustainable finance to end investors. The CSRD also considers the requirements arising from Regulation (EU) 2020/852 on the EU Taxonomy, which includes a uniform framework for the classification of sustainable investments and describes how to qualify a given activity as sustainable. The use of CSRD by companies will provide market participants with the information they need to assess their level of sustainability and will increase the link between a company's performance in this area and access to finance. The main assumptions of CSRD are presented in Table 2.

**Table 2.**  
*Main assumptions of CSRD*

Assumption	Description
Increasing the number of companies subject to obligatory reporting	<ul style="list-style-type: none"> <li>– from January 2024, large publicly traded companies currently covered by the NFRD (publication of the report in 2025),</li> <li>– from January 2025, other large entities<sup>4</sup> not currently covered by the NFRD (publication of the report in 2026),</li> <li>– from January 2026 public interest SMEs, i.e., mainly listed entities<sup>5</sup> (publication of the report in 2027),</li> <li>– from January 2027, non-EU entities that have a subsidiary in the EU and whose turnover exceeds EUR 150 million</li> </ul>
Reporting in accordance with the so-called double materiality principle	Entities are obliged to analyze, on the one hand, the impact of their activities on the environment, and, on the other hand, the opportunities and threats to their financial situation arising from the environment in environmental, social and corporate governance terms in the short, medium and long term.
Emphasis on enterprise strategies, standards and sustainability goals	Reporting is not limited to presenting the results and effects achieved in a given reporting year and aspirations. It is necessary to disclose strategies, policies, action plans, resources and measurable goals and progress towards their achievement.
Reporting covering the value chain	Companies are obliged to present relevant information covering the value chain, both on the supplier side ( <i>upstream</i> ) and in the area of product distribution to final customers ( <i>downstream</i> ).
Reporting of greenhouse gas emissions in the entire value chain	Companies report GHG ( <i>greenhouse gas</i> ) emissions throughout the value chain. Therefore, companies will require data on GHG emissions from their suppliers, and it will be possible to provide estimates if such information cannot be obtained.
Uniform ESRS reporting standards	The CSRD ends the freedom of choice of a reporting standard, requiring companies to report in accordance with the European Sustainability Reporting Standards (ESRS), which are expected to be adopted by the end of August 2023.
Digitization of reporting	The report on management activity and the sustainability statement included therein are prepared in a format that allows for machine reading and automatic data analysis.
Mandatory audit	The directive introduced the obligation to verify the disclosed information by a statutory auditor or another authorized entity - initially at the <i>limited assurance</i> level, and after the EC adopts the appropriate standard at the <i>reasonable assurance</i> level.

Source: elaborated on (PKO, 2023)

Meanwhile, work is underway on EC implementing regulations related to the application of CSRD, which primarily include the following (PKO, 2023):

- European Sustainability Reporting Standards (ESRS),
- European Single Access Point Regulation establishing a publicly available platform of data, including on sustainable development, relating to EU companies,
- Regulation regarding the preparation of external audit reports,
- Corporate Sustainability Due Diligence Directive (CSDD), which increases companies' obligations in terms of analyzing and disclosing information about their supply chains.

In order to enable comparability of company reports and the data presented in them, the European Commission is developing new non-financial reporting standards (ESRS), which will be obligatory for entities covered by the CSRD Directive (Figure 1).

NON-SECTOR-SPECIFIC-STANDARDS			SECTOR-SPECIFIC-STANDARDS /COMING LATER/
CROSS CUTTING STANDARDS			
ESRS 1 GENERAL PRINCIPLES	ESRS 2 GENERAL, STRATEGY, GOVERNANCE AND MATERIALITY ASSESSMENT DISCLOSURES REQUIREMENTS		
TOPICAL STANDARDS			SME STARNDARDS /COMING LATER/
ENVIRONMENT	SOCIAL	GOVERNANCE	
ESRS E1 CLIMATE CHANGE	ESRS S1 OWN WORKFORCE	ESRS G1 GOVERNENCE, RISK MANAGEMENT AND INTERNAL CONTROL	
ESRS E2 POLLUTION	ESRS S2 WORKERS IN VALUE CHAIN	ESRS G2 BUSINESS CONDUCT	
ESRS E3 WATER & MARINE RESOURCES	ESRS S3 AFFECTED COMMUNITIES		
ESRS E4 BIODIVERSITY & ECOSYSTEMS	ESRS S4 CONSUMERS & END-USERS		
ESRS E5 RESOURCE USE & CIRCURAL ECONOMY			

**Figure 1.** ESRS components – draft.

Source: study based on (EFRAG, 2023).

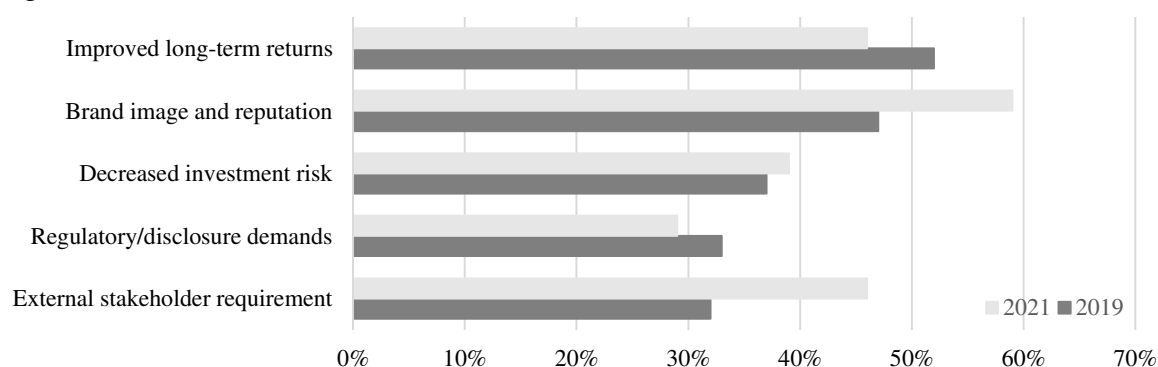
The ESRS consists of two cross-sectional standards (ESRS 1 and ESRS 2), 10 thematic standards and sector standards. The ESRS standard 1 describes the general principles and conceptual framework for reporting, while ESRS 2 describes general disclosures regarding the company, regardless of the topic or sector. The thematic standards include detailed reporting requirements in specific environmental areas (E1-E5); social, including labor and human rights areas (S1-S4) and those related to corporate governance (G1-G2).

#### 4. ESG standard – implementation practice to build resilience

The implementation of new rules for conducting business activities in compliance with the ESG standard is part of the commitment to achieve the UN sustainable development goals and climate neutrality by EU countries in 2050. According to the data of the Risk Resilience Report



(2021) 85% of surveyed respondents around the world stated that the issues related to the ESG standard are very important and important for their business, and 15% considered them as little important. Considering business areas that are influenced by the implementation of the concept of sustainable development, clients/customers were indicated first (54%), followed by human capital (47%) and supply chain (47%). Slightly fewer indications were given to: reputation (43%), physical assets (42%) and market/stock price (38%). Referring once again to the Risk Resilience Report (2021), it should be noted that despite the relatively high awareness of managers regarding the implementation of the ESG standard, only 16% of the surveyed companies model/forecast it in a comprehensive way. The reasons for the growing interest in the implementation of the ESG standard among management staff around the world seem interesting. BNP Paribas publications (2019, 2021) show that the five most important determinants (drivers) include improved long-term returns, brand image and reputation, decreased investment risk, regulatory/disclosure demands and external stakeholder requirement (Figure 2).



**Figure 2.** Top-5 drivers of ESG in 2019 and 2021.

Source: (BNP, 2019; BNP, 2021).

As Figure 2 shows, the order of drivers has changed in 2021 compared to 2019. While in 2019 improved long-term returns was the most crucial factor, in 2021 brand image and reputation took the leading position, whereas two factors, i.e., improved long-term returns and external stakeholder requirement took the second place. The obtained results can be interpreted in such a way that a significant group of managers working in the international business environment see better prospects for long-term financial benefits, improving the company's image among a wide range of stakeholders, as well as the possibility of attracting new investors and their capital in the implementation of the ESG standard. This is confirmed by the analysis of the Global Sustainable Investment Alliance (GSIA, 2021), according to which the value of assets from sustainable investment in the world reached USD 35 trillion in 2020, which means a 15% increase over the last two years. It is assumed that with such an increase, their value may exceed USD 50 trillion by 2025. Moreover, large investment funds compliant with ESG outperformed the rest of the market in 2020.

Companies operating in Poland are making increased efforts towards sustainable business, but in many respects they still lag behind the global average. As part of its ESG analyses, the consulting company E&Y has developed a study that concerns environmental issues. Considering the data contained in the Report (Wajer, Hummel, 2023), the following can be concluded:

- companies willingly declare emission reduction, but their goals are lower than those of companies worldwide - only 21% of companies declared negative, and 13% declared zero carbon dioxide emissions;
- 33% of companies do not intend to increase spending on reducing the negative impact on the natural environment, 33% declare they will increase it slightly;
- 22% of enterprises focus only on smaller or easily achievable goals with regard to negative impact on the environment;
- the most important motives in the fight against climate change include gaining a competitive advantage on the market, responding to the requirements of main stakeholders, compliance with regulations in force, compliance with the organization's goal and financial benefits;
- the ability to estimate the value of pro-climate activities is the problem for over 40% of Polish enterprises;
- to reduce greenhouse gas emissions, companies invest primarily in operations and supply chains, products and services, R&D, ICT and cybersecurity;
- only 20% of Polish companies managed to find employees suitably qualified in the field of environmental protection, while 46% are still looking for and recruiting them;
- 25% of organizations claim that too many groups in their organization deal with sustainable development, which makes it difficult to achieve goals;
- the most important external obstacles hindering the pursuit of sustainable development include uncertainty related to emerging regulations, difficult geopolitical and economic situation, as well as difficulties in obtaining financing for initiatives to combat climate change;
- however, as many as 52% of Polish entrepreneurs are convinced that their companies will be able to achieve the set environmental goals within the specified time.

Conducting a business transformation consistent with the concept of sustainable development should enable the organization to achieve goals related to increasing resilience, building long-term value and, consequently, ensuring development. However, many managers in Poland indicate several shortcomings regarding the implementation of the ESG standard. The most frequently raised issues include (PKO, 2023):

- Fear of disclosing sensitive information or other information that determines the company's competitive advantage;
- Copying of entries in reports by companies;

- Cost of implementation of the reporting system;
- Insufficient number of ESG and sustainability management specialists;
- Unfair competition from non-EU companies that apply lower sustainability standards.

However, it should be added that enterprises that do not report their progress in accordance with the CSRD will be exposed to various consequences, such as loss of trust and reputation, deterioration of their competitive position, or limited access to capital. In addition, financial penalties and legal sanctions, the level of which is determined by each country are provided. Their amount may depend on many factors, such as the size of the enterprise, repeated violations or the level of reporting irregularities. Currently, in accordance with the Polish accounting act, failure to prepare an activity report or including unreliable data in these reports is punishable by a fine or imprisonment of up to two years, or both (Sagnes, 2023).

## Conclusions

Creating conditions for long-term growth should be based on the principles of environmental protection, social justice and appropriate corporate governance (Sang, Chune, Young, 2019; Gillan, Koch, Laura, 2021). Business practitioners, especially global companies, emphasize that implementing sustainable development and the ESG standard is a way of building the company's resilience to social, economic and geopolitical changes as well as crises. Moreover, the current geopolitical situation should be a catalyst for changes, especially in the energy transformation. Special attention is paid to the following benefits resulting from the implementation of ESG (PKO, 2023):

- Possibility to increase the transparency and credibility of the company in the eyes of investors and consumers;
- Better company management;
- Increasing the enterprise innovativeness;
- Better risk management related to relationships with entities in the enterprise's value chain;
- Possibility to reduce costs and obtain better financial results;
- Preventing accusations of using the so-called greenwashing or other pseudo-PR messages;
- Limiting unfair competition;
- Possibility to identify and highlight positive aspects of the activity.

Many Polish companies are already on this path. They implement solutions that minimize the negative impact of their activities on the environment with greater or lesser success. The new reporting rules should be perceived not only through the prism of regulatory

obligations, but also through the opportunities to strengthen the market position of enterprises. Reporting both financial and non-financial data promotes better recognition of the actual opportunities and needs important for the development of the enterprise, which in turn constitutes important support in making operational and strategic decisions, and consequently in the process of building resilience (Folque, Escrig-Olmedo, Santamaria, 2021; Costa et al., 2022).

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