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WYDAWNICTWO POLITECHNIKI ŚLĄSKIEJ
ul. Akademicka 5, 44-100 Gliwice
tel. (32) 237-13-81, faks (32) 237-15-02
www.wydawnictwopolitechniki.pl

Sprzedaż i Marketing
tel. (32) 237-18-48
wydawnictwo_mark@polsl.pl

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FOREWORD

Presented number of Silesian University of Technology. Scientific Papers. Organization and Management Series. Presented papers contain result of researches conducted by various universities. The number consists of 39 papers.

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about: Industry 4.0, project management, marketing, service management, brand management, research and development, finances, consumption, human resource management, data management, information management, quality management, impact of COVID-19 on management, sustainable development, innovations, public management, economics, virtual reality, the implementation of Artificial intelligence in management and change management.

Radosław Wolniak

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EDUCATION OF HEALTH CARE PERSONNEL IN THE CONTEXT OF THE 4.0 REVOLUTION IN MEDICINE

Katarzyna BARŁÓG[1], Iwona MENDRYK[2*]

[1] The Maria Curie-Skłodowska University in Lublin; kasiad916@wp.pl, ORCID: 0000-0003-1356-094X
[2] The Maria Curie-Skłodowska University in Lublin; iwona.mendryk@mail.umcs.pl,
ORCID: 0000-0002-1127-0255
* Correspondence author

Purpose: The article attempts to identify the competences of health care specialists in the context of the 4.0 revolution based on the learning outcomes of postgraduate studies devoted to new technologies in health care.
Design/methodology/approach: An analysis of existing data (desk research) was carried out, focused on the planned learning outcomes in the 4 newest postgraduate fields of study devoted to the implementation of technology in health care facilities.
Findings: Universities focus on the development of technological and partly methodological competences, taking little into account social and personal competences, which are equally important for the implementation of medicine 4.0. Some universities design broad programs addressed to various health care specialists, and some universities focus on selected areas of medicine where technology may have the greatest application.
Research limitations: The offer of studies combining medicine and technology is still developing, therefore only 4 fields of postgraduate studies were analyzed.
Practical implications: The analyzes conducted showed two approaches to teaching technology in medicine, the first one notes the use of technology in various fields of health care, the second one focuses on specific medical specialties. The advantages and disadvantages of both approaches are discussed. It is also necessary to implement learning outcomes regarding personal or social competences, such as employees' attitudes towards rapid technological changes, motivation to learn and competences regarding interdisciplinary cooperation.
Social implications: Implementing changes in study programs will allow for more effective education of health care specialists in the area of new technologies, which is necessary to improve the quality of treatment.
Originality/value: The conducted study showed gaps in study programs, which will allow for their improvement and, as a result, increase the quality of teaching in the field of new technologies.
Keywords: education, health care, medicine 4.0, revolution 4.0, new technologies.
Category of the paper: Research paper.

1. Medicine 4.0

The fourth industrial revolution (revolution 4.0), resulting from the development of technology, leads to many organizational transformations in subsequent sectors of the economy, improving communication processes, data analytics, and various simulations (Bujak, 2017; Furmanek, 2018; Kiraga, 2016). The 4.0 revolution also increasingly covers the health care sector. Modern technologies enable personalization of therapy, which can reduce costs and at the same time increase its quality (Gaciong, 2016; Jose et al., 2022; Mathur, Sutton, 2017). New technologies in medicine significantly improve the effectiveness of treatment, enabling more precise disease diagnosis and analysis of specific disease indicators. Through increasing access to clinical databases, the use of artificial intelligence (AI) and big data analysis algorithms, specialists are able to treat increasingly complex medical cases (Seyhan, Carini, 2019; Sgro, Blancafort, 2020).

Despite the numerous benefits associated with the implementation of new technologies, medicine remains one of the slowest adapting sectors (Chanchaichujit, Tan, Meng, Eaimkhong, 2019; Jose et al., 2022). One of the key challenges of modern medicine in the area of technology is the integration of telemedicine, server applications and machine learning algorithms. Their synchronization can increase the level of health care (Rakhimov, Mukhamediev, 2022). At the same time, the development of technology requires improving the competences of health care specialists. Although technologies are widely used in various fields of medicine, the level of their use and their necessity vary depending on the specialization (Konttila et al., 2019). The result is a diversified demand for competences in the field of health technologies among the staff of individual specialties (Foadi, Varghese, 2022; Kirchberg, Fritzmann, Weitz, 2020; Torrent-Sellens, Soler-Ramos, 2018). However, most physicians are not adequately trained in new technologies, which limits their ability to fully utilize these tools. Low technological competences may lead to medical errors and also cause psychological barriers in the use of modern solutions (Foadi, Varghese, 2022). Therefore, there is a need to improve European educational standards in this area. The European Union should develop uniform standards for competencies related to Medicine 4.0 and adapt them to the needs and capabilities of member states, taking into account differences in the level of digitization of healthcare systems across these countries. It is also necessary to standardize terminology and establish precise guidelines regarding the scope of training for physicians in the field of Medicine 4.0. Postgraduate education programs should be based on clearly defined competencies that physicians will acquire upon completing their studies. The current lack of coherence in this field leads to significant discrepancies in the programs offered. At the same time, it is essential to outline a strategy in which technology is viewed as an integral tool in medical practice, with its importance appropriately reflected in physician training programs. In addition to investing in the digitalization of healthcare facilities, the European Union should simultaneously focus on

developing digital competences among healthcare workers, as it is crucial to maintain a balance between the use of technology and fostering empathetic relationships between doctors and patients (Jidkov et al., 2019).

2. Educational needs in health care from the perspective of the development of new technologies

The implementation of new technologies generates the need to improve the education of specialists in health care 4.0 (Jose et al., 2022). It is important for the development of technology in medicine to create appropriate conditions by health care managers, who play a decisive role in shaping an environment open to innovation and in change management (Jose et al., 2022). Key technological competencies that should be developed in doctors include: information management and security, digital communication, empowering the patient in therapy and the ability to use new technologies (Jidkov et al., 2019; Foadi, Varghese, 2022).

In addition to hard competences in the field of technology, critical thinking, independent acquisition of knowledge and the ability to use technology are important, which is becoming an increasing challenge because some tasks are taken over by machines and some still remain human (Kao et al., 2023). The development of technology in medical education solves many problems related to traditional education, e.g. medical simulators solve the problem of access to actors playing various disease states, and machines enable safe training and improvement of skills in controlled conditions. However, it is important to understand the relationship between the costs of implementing new technologies and the benefits for the development of competences (Scalese, Obeso, Issenberg, 2008), including social ones, because technologies can improve communication between health care specialists and patients (Blahun et al., 2022).

Despite the increasing precision of technological innovations and their popularity in medicine, there are doubts about the reliability of tools, the accuracy of diagnoses and the susceptibility of algorithms to errors (Seyhan, Carini, 2019). It is worth emphasizing, however, that technology alone is not enough for the full development of medicine. Social aspects and focusing on the needs of individual patients are also important (Ioppolo, Vazquez, Hennerici, Andres, 2020). When working with a patient, although precise diagnosis, data collection and analysis using technology are crucial, they are not enough to achieve therapeutic success. An important element of therapy, especially in the case of chronic treatment, is the patient's motivation. As health improves, patients may lose determination, which negatively affects the effects of treatment (Chen, Tang, Guo, 2022; Tavakoly, Behzhad, Ferns, Peyman, 2020). For this reason, apart from technology, the patient's psychophysical and emotional aspects, as well as the reactions of his loved ones, are also important.

Currently, the literature on the subject lists several key competencies regarding the implementation of changes related to the Industrial Revolution 4.0, these are technical, methodological, social and personal competencies (Hecklau et al., 2016; Jose et al., 2022). Technical competencies refer to the use of technology information and communication, including processing large amounts of data, while methodological competences are the area of being innovative, engaging in strategic tasks and solving emerging problems, and continuous learning. The area of social competences in the implementation of Industry 4.0 is the ability to cooperate with people from various backgrounds, use knowledge and skills and share them with others. In turn, a key personal competence is flexibility, which manifests itself, among other things, in adapting to changes resulting from the development of technology, supporting new initiatives and coping with emerging challenges. Basic competencies in particular areas are presented in table 1.

Table 1.
Key competencies for the effective implementation of Industry 4.0

Technical Competency	Methodological Competency	Social Competency	Personal Competency
▪ State-of-the-artknowledge ▪ Technical skills ▪ Process understanding ▪ Handling smartdevices, apps, smart media ▪ Data/information processing skills ▪ Understanding IT security	▪ Creativity ▪ Entrepreneurial thinking ▪ Problem solving ▪ Conflict solving ▪ Decision making ▪ Analytical skills ▪ Research skills ▪ Efficiency orientation	▪ Intercultural skills ▪ Language skills ▪ Communication skills ▪ Networking skills ▪ Ability to work in a team ▪ Ability to be compromise and cooperative ▪ Ability to transfer knowledge ▪ Leadership skills	▪ Flexibility ▪ Ambiguity tolerance ▪ Motivation to learn ▪ Ability to work under pressure ▪ Sustainable mindset ▪ Compliance

Source: Hecklau et al., 2016; Jose et al., 2022, p. 3.

3. Own research methodology

3.1. Subject and purpose of research

The research purpose of the work was to identify the necessary competences of health care specialists in the context of the development of Industry 4.0 based on the learning outcomes of postgraduate studies dedicated to the implementation of technologies in health care. It is also important to compare the assumed effects in study programs to the model of key competencies of Industry 4.0: technological, methodological, personal competencies and social. The practical purpose of the work was to formulate recommendations for people building programs and study plans in the field of health care, as well as to present the possibilities of developing current staff through postgraduate studies or certification courses. The main research question posed in the

study was: what key competencies for the effective implementation of Industry 4.0 are included in postgraduate study programs addressed to health care specialists?

3.2. Research sample

The study was conducted by analyzing existing data (desk research). Postgraduate study programs were analyzed. The key to selecting the research sample was the financing of the postgraduate studies program from the state budget as part of competitions announced by the Medical Research Agency. Four postgraduate programs were used in the analyses:

1. Postgraduate program at the Jagiellonian University "Future technologies in clinical applications" (polish version: *Technologie przyszłości w zastosowaniu klinicznym)*[1].
2. Postgraduate study program carried out at the Faculty of Medical Sciences in Zabrze, Medical University of Silesia in Katowice "Artificial intelligence and robotics in medicine*"* (polish version: *Sztuczna inteligencja i robotyka w medycynie)*[2].
3. MBA study program at Lazarski University „MBA Healthcare Innovation & Technology”[3].
4. 4.Postgraduate program at Lazarski University "Hospital assessment of innovative medical technologies" (polish version: *Szpitalna ocean innowacyjnych technologii medycznych*)[4].

[1] According to the information included in the study program, "The studies are carried out under Project No. 2023/ABM/06/00004 Mon. "Innovations in medical education and practice (InnoWMed) - Increasing the competences of medical staff in the field of education, translational medicine, computational techniques, 3D visualization techniques with elements of Artificial Intelligence", financed by the Medical Research Agency under competition No. ABM/2023/6".https://www.mckp.uj.edu.pl/studiaabm/technologie-przyszlosci-w-zastosowaniu-klinicznym/#program

[2] According to the information included in the study program: Postgraduate course developed in connection with the implementation of the contract concluded with the Medical Research Agency, the subject of which is the implementation of the project: "Innovative medicine based on facts, IT, AI and robotics". Project financed by the Medical Research Agency, Poland, competition number No. ABM/2023/6 for the development and implementation of an original postgraduate program in the field of biomedical sciences. https://medycynainnowacyjna.sum.edu.pl/wp-content/uploads/2024/04/Zacznikr1doUchwayNr24_2024.pdf

[3],[4] The program was developed and implemented as part of the project entitled "Competences for the development of an innovative health care sector. Innovations and technologies are the key to increasing health value and building a sustainable system", under contract No. 2023/ABM/06/00010 - 00. The project is financed from the state budget by the Medical Research Agency under the competition No. ABM/2023/6 for the development of and implementation of an original postgraduate program in biomedical sciences.
https://ckp.lazarski.pl/mba/mba-healthcare-innovation-technology-mba-hit/#pick-5
https://ckp.lazarski.pl/studia-podyplomowe/akademia-rynku-ochrony-zdrowia/szpitalna-ocena-innowacyjnych-technologii-medycznych-hb-hta/#pick-20

4. Presentation of results

Common to the studies surveyed is a focus on artificial intelligence (AI), 3D printing issues and big data analytics. These are key issues for the implementation of Industry 4.0. In addition to universal knowledge, there are also issues specific to medical technologies.

As part of the postgraduate studies "Technologies of the future in clinical application", learning outcomes are assumed that relate, among others, to:

- standards and management of medical data (e.g. source data analysis, cleaning, pseudo-anonymization, data quality assessment),
- the process of designing and improving three-dimensional representations of biological objects and structures used in medicine, preparing pre-operative processes,
- 3D printing process and three-dimensional visualizations using immersive technologies,
- design and implementation of applications using immersive technologies for medical education and improvement of medical practices,
- design, synthesis and development of drugs using three-dimensional models,
- programming neural networks and analyzing medical data, creating predictive models, automating processes and creating medical applications.

The presented learning outcomes therefore focus on technical and methodological competences (problem solving, decision making, analytical skills, research skills). There are 29 knowledge and skill outcomes in total.

This postgraduate study program includes educational outcomes that the authors of the program classified as social competences. Only one of them refers to social competence (cooperation with the staff of health care units), and some of them refer to personal competence (e.g. motivation to deepen knowledge or awareness of one's own limitations). Effects in the area of social competences, assumed by the authors:

- The participant is ready to use objective sources of information.
- The participant is ready to take care of the safety and ergonomics of working conditions at positions using modern technologies in medicine.
- The participant is ready to optimize cooperation with the staff of health care units and optimize the work of interdisciplinary teams using innovative technologies.
- The participant is ready to take conscious and professional actions in the field of new technologies in medicine.
- The participant is ready to independently expand knowledge and continuous professional development.
- The participant is ready to formulate opinions on various aspects of professional activity in the implementation of modern technologies in medicine.
- The participant is ready to diagnose his or her own limitations and self-assess educational deficits and needs.

- The participant is ready to take responsibility for decisions made as part of his professional activity.
- The participant is ready to formulate conclusions based on his or her own analyzes or observations.

The postgraduate program is not dedicated to selected medical specializations, but is broadly addressed to specialists in various fields medicine, bioengineers, biotechnologists and bioinformaticians.

As part of the postgraduate studies "Artificial intelligence and robotics in medicine" learning outcomes were planned regarding artificial intelligence, robotics, big data analysis, but also modeling of various body parts based on knowledge of anatomy, physiology and biophysics. The graduate will have the ability to present and argue the advantages and threats of introducing rotary technologies or based programs on AI in individual departments of medical services. A total of 38 results have been planned in the area of knowledge and skills, which focus on technical competences (especially AI and big data) and methodological competences (including: creativity, problem-solving, decision-making, analytical skills, research skills, efficiency orientation).

Out of 9 learning outcomes categorized by the authors of the program as social competences, only two refer to the area of social and personal competence (critical evaluation of acquired knowledge combined with motivation to develop it, as well as compliance with ethical principles).

Importantly, the study program includes key areas of medicine in which artificial intelligence and robotics may have particular applications. The areas of medicine included in the postgraduate study program are: biophysics, anatomy, surgery, cardiology, and neurorehabilitation. According to the program authors, technology may be particularly useful in the following areas: implants and artificial organs, telemedicine, rehabilitation and diagnostics, e.g. musculoskeletal dysfunctions in medicine and sports, as well as hearing and speech engineering.

Lazarski University offers two fields of study financed by the medical research agency as part of the 2023 competition. One of the fields is MBA Healthcare Innovation & Technology. The study program defines 6 main areas: vision of development, Eco-system of health care, leadership 2.0, New Product Development - from idea to commercialization; clinical trial of new technology and innovator practice. Detailed content for each area is provided in Table 2.

Table 2.
Key areas of the MBA study program: Healthcare Innovation& Technology

Vision of development 1. Strategic Management 2. Change Management and Leadership 3. Decision Making 4. Sustainable Development 5. Corporate Finance 6. Budgeting and Controlling 7. Strategic Marketing 8. Digital Marketing 9. Process Management 10. Knowledge Management and Intellectual Property 11. Strategic Game	**Eco health care system** 1. Models of healthcare organization and financing 2. Value Based Healthcare - a new paradigm in healthcare 3. Innovations in healthcare 4. AI in health 5. Medical technologies - trends and development processes 6. HTA - central and hospital perspective 7. Financing healthcare services and medical technologies 8. Legal aspects of the healthcare sectorin the context of innovative medical technologies
Clinical trial of new technology 1. Introduction to Clinical Trials 2. Legal Basis for Clinical Trials 3. Ethical Basis for Clinical Trials 4. Preclinical Studies and Non-Commercial Studies 5. Clinical Trial Registration 6. The Role of the URPL 7. Biostatistical Basis for a Good Clinical Trial. Analysis of Clinical Trial Results 8. Economic Basis for a Good Clinical Trial 9. Creating Trial Documentation 10. Investigator, Coordinator, Site - Roles and Tasks 11. Clinical Trial Support Center 12. Sponsor and CRO. Feasibility. Managing a Trial as a Project 13. Monitoring Clinical Trials 14. Drug Safety and Phase IV Studies 15. Bioavailability and Bioequivalence Studies. Early Phase Studies 16. Clinical Trials of Medical Devices 17. Differences in Clinical Trials in Various Fields of Medicine	**New Product Development - from idea to commercialization** 1. Technology development path - from idea to market. Business and registration aspects 2. Experiment design and analysis. Preclinical evaluation and assessment 3. Business strategies and models in the high-tech industry 4. High-tech project management - R&D technology development. The perspective of the researcher, center, financing institution 5. Innovation business management 6. Sources of financing for innovative activities in healthcare 7. Workshop on negotiations with investors 8. Valuation of research projects for commercialization 9. Presentation and storytelling: as a tool for building strong brands 10. Marketing strategies for innovative ventures
Leadership 2.0 1. Leadership Self-Awareness Workshop 2. Conflict and Negotiations 3. Effective Communication Workshop 4. Leadership and Career Development Coaching 5. Team Leadership and Relationship Management 6. Psychology in Management 7. Creativity and Innovation Workshop 8. Networking Practice	**The Innovator's Practice** 1. Case study – Success stories 2. "Failure cases as powerful lessons" 3. Study visit to the academic Technology Transfer Center 4. Study visits to industrial partners - Innovation development practice (choice of two proposals) 5. Measuring Impact - target, breath and depth of change 6. Coaching session 7. Methodology of the diploma project. Vision, Value proposition, Validation - project pitching roadmap 8. Diploma seminar

Source: postgraduate program https://ckp.lazarski.pl/mba/mba-healthcare-innovation-technology-mba-hit/?gad_source=1&gclid=Cj0KCQiAlsy5BhDeARIsABRc6Zs3posb8syoH6LMmMK_taMDjI1isSHKKsKY9cMJDHLuVJyBss49e2gaAjYEEALw_wcB#pick-5, 12.11.2024.

The learning outcomes proposed in the study program refer to technical and methodological competency. One of the modules: Leadership 2.0 refers to social and personal competency in 6 out of 8 topics (only Leadership Self-Awareness Workshop and Conflict and Negotiations can be more closely assigned to methodological competency). The postgraduate program consists of 460 hours in total, of which the Leadership 2.0 module covers 64 hours, which is 13.91% of classes. The postgraduate studies are dedicated to various specialists related to health care, the authors of the studies do not distinguish specific areas of medicine.

The second field of study at Lazarski University, financed by the Medical Research Agency, is postgraduate studies: "Hospital assessment of innovative medical technologies". Similarly to the MBA studies, the program distinguishes 6 main areas: hospital innovation management, introduction to HB-HTA (Hospital Based - Health Technology Assesment), HB-HTA practice, organization of the HB-HTA unit, team management and communication for the development of innovation hospital and diploma module. Details are presented in Table 3.

Table 3.
Key areas of the postgraduate program Hospital evaluation of innovative medical technologies

Hospital Innovation Management 1. The Place of the Hospital in the Healthcare System and Directions of Transformation 2. Legal, Organizational, and Financial Aspects of Hospital Operations 3. Managing Hospital Development Based on Innovations 4. Sources of Financing for Innovative Medical Technologies	**Organization of the HB-HTA unit** 1. Organization of the HB-HTA unit - study visit 2. Evaluation and monitoring of the implementation of innovative technology
Introduction to HB-HTA 1. Health Technology Assessment. HTA versus HB-HTA 2. The role of the HB-HTA report in the implementation and financing of innovative health technologies 3. Introduction to the HB-HTA methodology and evaluation of HB-HTA reports 4. Analysis of the decision problem 5. Clinical analysis 6. Economic analysis 7. Organizational analysis	**HB-HTA Practice** 1. Tools in the HB-HTA process 2. Decision problem analysis workshop 3. Clinical effectiveness and safety of medical technology analysis workshop, taking into account patient opinions 4. Impact of medical technology on hospital service provision workshop 5. Economic efficiency and impact of medical technology on hospital/unit budget analysis workshop 6. Reporting and presentation of HB-HTA analysis
Team management and communication for the development of hospital innovation 1. Team Management and Communication 2. Conflict Management	**Diploma module** 1. Mentoring session 2. Diploma seminar

Source: postgraduate program https://ckp.lazarski.pl/studia-podyplomowe/akademia-rynku-ochrony-zdrowia/szpitalna-ocena-innowacyjnych-technologii-medycznych-hb-hta/#pick-20access 12.11.2024

However, the module: Team management and communication for the development of hospital innovation, includes 16 hours of classes out of 190 for the entire postgraduate studies. This means that 8.42% of classes are dedicated to social and personal competency, and the rest are focused on technical and methodological competency.

Postgraduate studies are aimed at various specialists related to health care and do not distinguish specific areas of medicine.

5. Conclusions

The analyzes carried out lead to the conclusion that the study programs largely refer to the area of technological and partly methodological competences. The creators of the studies focus on hard competencies, on current knowledge, technical skills, and understanding of processes, including new technologies, applications and devices.

Few effects refer to other areas of key competencies for Industry 4.0, such as: ability to work under pressure, team, interprofessional and intercultural cooperation, leadership skills, and flexibility in adapting to new challenges. Postgraduate study programs pay little attention to social and personal competences, which are as important as technological competences for the challenges of Industry 4.0 (Hecklau et al., 2016; Jose et al., 2022). Unfortunately, the above-mentioned areas are covered only to a small extent in study programs.

Some universities try to show the importance of technology in various areas of health care: drug production, surgery, medical diagnosis (data analysis), or the use of 3D printing. In turn, some universities focus their content on key areas of medicine where Industry 4.0 technology is particularly useful, such as: biophysics, anatomy, surgery, cardiology, neurorehabilitation. The question remains open about the effectiveness of both approaches to acquiring technological competences by health care specialists and the coherence between first-cycle, second-cycle or uniform studies (enabling participation in postgraduate studies) and the content taught during postgraduate studies. The basic learning outcomes of medical studies include outcomes relating to new technologies and their use in medicine (Regulation of the Minister of Science and Higher Education, 2019, 2023, 2024), universities also independently expand the basic effects listed in the regulations with content related to industry 4.0 technologies (Barłóg, Mendryk, 2024), however, in practice, there are large differences in this area of competence among specialists in various fields of medicine (Foadi, Varghese, 2022; Kirchberg, Fritzmann, Weitz, 2020; Torrent-Sellens, Soler-Ramos, 2018). This is not a Polish problem only; in other European countries, including the UK, postgraduate programs related to medicine 4.0 also focus on selected areas of medicine, completely omitting some of them, e.g. psychiatry (Jidkov et al., 2019).

It seems that some of the content planned for postgraduate studies should also be included in long-cycle studies, so that each graduate has the basic competences necessary for the implementation of industry 4.0 technologies in health care facilities. It is important to take into account not only technological and methodological, but also social and personal competences (Hecklau et al., 2016; Jose et al., 2022). Additional, expanded research should address specific

areas of medicine and competency needs for future developments. However, the presented theses require empirical verification through research on health care staff, both managers and specialists - practitioners.

The presented study has limitations regarding the size of the research sample and to a large extent it can be understood as a pilot, but particularly important due to the growing trend of technological directions addressed to health care specialists. The analyzed fields of study appeared to a large extent in the university's offer in recent months, which is an important need, considering the strategic importance of health care for the functioning of society and the financing of these postgraduate study programs from external funds. It is also worth noting that postgraduate studies are not the only ones recently offered by universities that combine the issues of industry 4.0 and medicine. This article is limited to postgraduate studies, taking into account their specificity, including (Article 160 of the Act of 20 July 2018 - Law on Higher Education and Science): length of study (studies last no less than 2 semesters) or obtaining qualifications (postgraduate studies enable only partial qualifications at level 6, 7 or 8 of the Polish Qualifications Framework). The adoption of partial effects results in concentration on a relatively narrow thematic scope and omission of teaching/developing other, more general skills. It would be interesting to see how the graduates of these studies use the acquired skills and whether they feel they are sufficient.

The considerations presented in the article are based on analyses of the learning outcomes of postgraduate studies conducted at selected Polish universities. It is important to emphasise that the problems associated with the education of health professionals in the context of contemporary challenges are global in nature. The development of technology and techniques brings new possibilities for diagnosis and treatment of patients. It is becoming necessary to develop new competencies. Universities around the world are facing this challenge. The issues raised in the article and the research method used can be used both for research based on international comparisons and for analyses aimed at changing the educational programmes implemented at universities in every region of the world.

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BARRIERS IN ACHIEVING PROJECT VALUE IN RESEARCH AND DEVELOPMENT PROJECTS AT UNIVERSITIES

Oksana BEZGIN[1], Dorota KUCHTA[2*]

[1] Faculty of Management, Wroclaw University of Science and Technology; oksana.bezgin@pwr.edu.pl
[2] Faculty of Management, Wroclaw University of Science and Technology; dorota.kuchta@pwr.edu.pl, ORCID: 0000-0002-9747-0759
* Correspondence author

Purpose: The primary aim of this article is to identify barriers to managing R&D projects conducted at universities, based on literature and case studies. Additionally, the paper aims to define the specificity of the concept of barriers in managing R&D projects conducted at universities in the context of the concepts of risks and uncertainties and to propose the fundamentals for barrier management in R&D projects conducted at universities.
Design/methodology/approach: A literature review and a case study were used to define and identify barriers in managing R&D projects conducted at universities. Conceptual analysis was applied to propose a system for managing the barriers.
Findings: Barriers are a concept worth analysing separately from that of risk and uncertainty, as they represent a fixed feature of R&D projects and their environment. The management of barriers is primarily future-oriented and is based on a learning process. At the same time, it can bring immediate benefits to the projects currently being implemented. This system should be embedded within a university-wide project management system.
Research limitations/implications: The findings described in the paper require case studies of practical application, through which the list of barriers and the corresponding immediate and future measures can be completed.
Originality/value: The targeted audience of this paper includes individuals involved in the management of R&D projects at universities, whether as project managers, project team members, university division managers, or employees of project funding institutions. The paper draws their attention to features of projects and their environment which, being of a fixed nature, present constant obstacles to achieving project success. It emphasises that steps should be taken to gradually remove these barriers.
Keywords: project value, project barrier, research project.
Category of the paper: research paper.

1. Introduction

Research and development (R&D) projects are inherently associated with risks, uncertainties, and barriers, which often manifest as threats (Parys, 2012), preventing the achievement of the value sought by project stakeholders. Today, it is widely accepted that the success of any project is tied to achieving the value sought by its stakeholders (Kerzner, 2017).

Risks and uncertainties in projects (defined in various ways), including R&D projects, are frequently analyzed (e.g. Klaus-Rosińska, 2019). However, the concept of barriers, which is indeed related to risks and uncertainties but is not synonymous with them, can offer new insights into the management of R&D projects and is less frequently a subject of scientific research. In R&D projects, barriers are closely linked to the project lifecycle, and the risk of their occurrence is typically associated with a specific timeframe during which the project is implemented (Szyjewski, 2004). Due to the complexity and characteristics of R&D projects, these barriers can be highly diverse and often arise unexpectedly during different phases of the project (Morris et al., 1991). To minimize the impact of these unforeseen failures, it is essential to plan corrective actions and select appropriate tools to support the process of overcoming encountered barriers (Duncan et al., 1983). The existence of barriers should not be viewed as obstacles that prevent project implementation but rather as a foundation for developing actions to address them effectively. Moreover, they can serve as potential sources for increasing the value generated by R&D projects.

The primary aim of this article is to identify barriers in managing R&D projects conducted at universities, based on literature and case studies. The secondary objectives are as follows:

- To define the specificity of the concept of barriers in managing R&D projects conducted at universities in the context of the concepts of risks and uncertainties.
- To propose the fundamentals for barrier management in R&D projects conducted at universities.

The achievement of these objectives is intended to serve the general purpose of maximizing the value delivered by R&D projects conducted at universities.

The structure of the article is as follows: In Section 2, we present the concept of barriers in project management. In Section 3, we discuss the issue of values sought to be attained in R&D projects implemented at universities, noting that without achieving the desired values, the projects will not be considered successful. In Section 4, we identify barriers to R&D projects conducted at universities, and in Section 5, we propose a concept for the management of R&D project barriers. The paper concludes with some final remarks.

2. The Concept of Barriers in Project Management

Let us begin by comparing the concepts of risk and barrier in the context of project management.

According to the *Polish Language Dictionary* (https://sjp.pwn.pl/), risk is defined as "the possibility that something will fail; also: an undertaking with uncertain outcomes" and "taking on a specific danger". Risk in a project is defined as the possibility of undesirable results or failure to achieve set goals, which may disrupt the course of the project (Smith, Merritt, 2002).

A barrier, on the other hand, is defined by the *Polish Language Dictionary* (https://sjp.pwn.pl/) as "a natural obstacle that hinders or prevents movement" and "a thing that hinders the occurrence of a phenomenon or situation". In the context of project management, barriers are defined in the literature as obstacles that prevent the occurrence or execution of a specific group of tasks within a given undertaking (Liebert, Trzeciak, 2016).

Based on a synthesis of the literature (Smith, Merritt, 2002, Kerzner, 2017), a definition of barriers tailored to the general understanding of project management and the needs of R&D projects can be proposed:

A barrier in a project is a condition or characteristic, existing at the time of project analysis and considered permanent, that pertains to the project or its environment, or a set of such conditions or characteristics. These factors may hinder or prevent the achievement of project objectives by causing delays, increasing costs, limiting resources, or negatively affecting the quality of outcomes. Barriers can be internal (e.g., lack of team competencies, insufficient planning) or external (e.g., changes in legal regulations, unforeseen events). In other words, a barrier may trigger a risk of not meeting project objectives. In this sense, a barrier is a source or cause of risk, though not every source or cause of risk qualifies as a barrier, as a barrier is characterized by its permanence and is an inherent feature of the project or its environment. A barrier ceases to be a source of risk once it is removed. Similarly, mitigating a barrier will positively influence the attributes of the risk it generates.

Bond and Houston (2013) identify three main types of barriers to innovation projects, which are also significant in the context of R&D projects:

1. Strategic-structural barriers, related to regulations and bureaucracy.
2. Technological-market barriers, stemming from technical limitations and market demands.
3. Socio-cultural barriers, associated with resistance to change and cultural differences.

Some researches (Grusza, Trocki, 2013) add that barriers can be categorized as internal or external. Internal barriers include organizational and project-specific issues, such as a lack of resources or inadequate management procedures. External barriers, whether closer to the project (e.g., stakeholder relations) or more distant (e.g., legal or economic environments), also significantly impact project progress.

Various barriers exist in new product development projects, arising from both internal company resources and external relationships (Liebert, Trzeciak, 2016). Research in different countries, such as Brazil (Feldens et al., 2012), Australia (Kotey, Sorensen, 2014), and Spain (Madrid-Guijarro et al., 2009), highlights severe financial constraints and insufficient intellectual capital as key obstacles in new product development. Additional challenges, such as corruption, lack of transparency (Feldens et al., 2012; Lekovic, 2013), improper resource allocation, or infrequent product updates (Engberg et al., 2015), further hinder R&D activities. Relationships with the company's environment, including suppliers and partners in strategic alliances, often lead to conflicts that can result in project abandonment (Athaide et al., 2011; Chin, Lam, 2004).

Communication barriers play a significant role in the idea selection process and project execution. These issues include difficulties in employee communication (Felekoglu et al., 2013; Lechler, Thomas, 2015; Sojkin, 2003), lack of specialized project teams (Gerwin, Barrowman, 2002; Sandmeier, 2008), and insufficient project manager competencies (Badir et al., 2012; Bonner et al., 2002; Nauman et al., 2010). Additionally, a lack of trust and differing perceptions of requirements for new products also pose significant challenges (Lynch et al., 2014).

3. Values associated with research and development projects

Research and development projects conducted at universities, like all projects, aim to deliver value to stakeholders. However, both the stakeholders of such projects and the values they expect are closely tied to the nature of these projects. These values are outlined in Table 1.

An R&D project will be deemed successful by stakeholders to the extent that the desired values have been achieved. Barriers are obstacles of a permanent nature that impede the attainment of these values. Therefore, it is essential to identify barriers in relation to these values and implement measures to manage them effectively.

Table 1.
Values desired to be achieved in research and development projects conducted at universities

Types of value			
Material	**Non-material**		
	Professional	**Psychological**	**Social**
Compensation from the project, functional remuneration for managing the project, profit (or indirect profit) from the sale (or leasing) of new technology, additional remuneration for employees, salary bonuses, bonuses for employees, additional remuneration for employees from the project, acquisition of new research equipment, profits from leasing research equipment, indirect revenues, profit (or indirect profit) from the implementation of new technology, increase in base salary, awards, increase in internal funding for the unit, increase in external funding for the unit, revenue from the sale of new technology, revenue from cost reductions or simplification of production processes, increase in the total value of the enterprise.	Gaining professional experience through performing managerial functions, improving the qualifications of one's employees, affiliation with published scientific articles, gaining professional experience through publishing scientific papers, career advancement, obtaining an academic title, improving the qualifications of one's employees, achieving a better result in categorization, creating opportunities for the development and dissemination of new technology (spin-off), creating opportunities for the development and dissemination of new technology (spin-out).	Gaining new experiences, enriching skills and personal development, enhancing employee skills, establishing new business relationships, building the brand of products or services, social advancement, prestige, recognition, prestige for the unit, gaining new experiences, prestige for enterprises, increasing enterprise innovation, higher market position.	Enabling the research team to fulfill their professional aspirations, creating the project's goal as a response to societal or market needs, shaping intellectual capital, providing public access to scientific publications, making new technology available as a response to societal or market needs, indirect participation in creating opportunities for new knowledge, improving quality of life, simplifying production processes, indirect participation in creating opportunities for new knowledge, indirect participation in improving quality of life, simplifying production processes.

Source: own elaboration based on Eckes-Kondak, 2021.

4. Barriers in research and development projects conducted at universities

4.1. Barriers identified in the literature

Research and development projects carried out at universities encounter numerous barriers that can limit the maximization of their value. It is important for these barriers to be viewed multidimensionally, and their minimization should be a priority for both the project manager and other stakeholders. The active involvement of all interested parties during the project planning stage allows for better preparation to address barriers in the later phases of the endeavor.

According to Eckes-Kondak (2021), considering the specifics of research and development projects at universities, the following barriers to maximizing their value can identified:

A. improperly defined project goals,
B. lack of a realistic project plan, including scope, timelines, and budget,
C. insufficient resource base,
D. inadequate competence and experience of the project manager,
E. insufficient skills and misalignment of the project execution team,
F. improper or limited communication,
G. lack of or inappropriate use of project management methodologies,
H. complex administrative structure and prolonged procedures,
I. ineffective collaboration with stakeholders and failure to consider their expectations in the project.

The phenomena or circumstances listed above will be considered barriers only if they are of a permanent nature. For instance, ineffective collaboration with stakeholders must have persisted over a significant period despite efforts made to improve it. Each of the listed barriers significantly impacts the maximization of the value generated by research and development projects. Managing these barriers requires a comprehensive approach that includes planning, monitoring, and collaboration with stakeholders. Early identification of these barriers and appropriate responses to them can significantly increase the chances of project success and the maximization of its value.

4.2. Barriers identified in the case study

Case study description

The case study pertains to an R&D project conducted at one of the largest Polish universities between 2009 and 2011. The objective of the project was to develop a concept for a costing system tailored to the university's needs. The problem intended to be partially addressed through the project was that the costs associated with all university activities—teaching, research, and administration—and all cost objects, such as students, employees, courses, and projects, were calculated in a manner that did not accurately reflect the actual utilisation of financial and material resources.

The proposed concept was based on the Activity-Based Costing (ABC) approach, which measures the resource usage for each activity individually, ensuring that the resulting costs of activities and cost objects are more closely aligned with reality. This approach necessitates a significant amount of detailed information regarding how individual activities are performed, the resources consumed, and the time spent on them. The design of such a system could not succeed without the active involvement of all university employees across all departments. It is worth emphasising that interviews and thorough documentation reviews were conducted,

requiring complete transparency and the potential exposure of hidden inefficiencies in the current cost calculation system.

Regrettably, the project was only partially successful. The primary reason for this was the lack of willingness among employees to collaborate and disclose information. They were not motivated to dedicate time to providing the necessary data and were apprehensive about revealing details of the existing costing systems, which they perceived to be far from ideal.

Case study results

In hindsight, barriers inherent to the project were identified in the case study in a post factum analysis, and are presented in Table 2.

Table 2.
Barriers identified in the case study

Id	Barriers	Project implementation stages
1	Lack of tools for rewarding/motivating the project team	Stage 4: Implementation, control, and completion of the research project
2	Lack of clear rules/recommendations for project management methods	All stages
3	Insufficient informational support from administration	All stages
4	Researchers are difficult-to-manage employees (individualists)	Stage 4: Implementation, control, and completion of the research project
5	Lack of procedures for hiring members for the project team	Stage 2: Approval and initiation of the research project
6	Overburdening project managers with administrative tasks	All stages
7	Lack of project management training for project managers	All stages
8	Inability to fully plan research (results are uncertain)	Stage 1: Initiation and planning of the research project
9	Lack of knowledge of project management methods or techniques	All stages
10	Administrative resistance due to concerns about greater/new responsibilities	Stage 2: Approval and initiation of the research project. Stage 4: Implementation, control, and completion of the research project
11	Resistance to sharing data	Stages 2, 3, 4
12	Ineffective communication with the administration of the organization implementing the project	All stages
13	Requirement for overly detailed preparation of project documentation	Stage 1, sub-stage: Preparation of the project proposal
14	Inability (funding institutions do not allow this) to introduce corrections to financing applications	Stage 2: Approval and initiation of the research project. Sub-stage: Approval
15	Failure to provide exemptions from other duties for the project manager and/or project team members	Stage 4: Implementation, control, and completion of the research project. Sub-stage: Project implementation
16	Lack of predisposition of managers to lead project teams (they are researchers, not management specialists)	All stages
17	Lack of or insufficient procedures for monitoring and controlling results during project implementation	Stage 4: Implementation, control, and completion of the research project. Sub-stage: Monitoring and verification

Source: Yakivets, 2022

The occurrence of specific problems is closely related to the lifecycle of a research and development project. The risk of encountering a particular problem is associated with a specific timeframe during which the project is being implemented. However, it should be emphasized that, due to the nature of research and development projects, these problems are highly diverse and may arise unexpectedly and randomly at different points in time.

In summary, managing the barriers and problems encountered during the implementation of a research and development project is one of the key elements in generating the value of such projects at universities. Early identification of barriers, problems, and difficulties in a project not only minimizes their undesirable impact on the project and its success but also allows for the identification of unforeseen sources of value generation within the research and development project. In the next section, the initial idea of a system of barriers management in R&D projects implemented ate universities will be sketched.

5. Managing barriers to achieve values in research and development projects conducted at higher education institutions

To minimize value losses resulting from emerging problems, the key task of the project manager is to structure the approach to managing these uncertainties by implementing risk management. The foundation of this process involves identifying project barriers, evaluating them, planning potential responses in case of their occurrence, and controlling corrective actions (Smith, Merritt, 2002). Early identification of barriers in the initial phases of the project allows for their monitoring and control throughout the project lifecycle (Wang et al., 2010). This enables the planning of appropriate responses that help minimize the effects of project uncertainties and increase the project's value.

In Table 3, responses to the barriers identified in the previous section are proposed. All responses have been developed under the assumption that we are addressing a barrier—a permanent characteristic of the project or its environment that cannot be quickly resolved, for instance, by replacing one or two team members or by suggesting the use of Excel for project management. Letters in the ID column refer to the barriers identified based on the literature, while numbers correspond to those identified in the case study.

Table 3.
Barriers in R&D projects implemented at universities and responses to them

Id	Immediate responses	Responses for the future
A	Modifying the phrasing of the goal for the purposes of internal project management	Proposal for training programmes for research and administrative staff
B	Adjusting the plan within feasible limits to align with the needs of internal project management	Proposal for training programmes for research and administrative staff
C, H, 5	none	Proposal submitted to senior management to address this issue in the future
D, E, G, 9, 16	Minimum competencies quick course	Proposal for training programmes for research and administrative staff
F, H, 10, 11, 12	Identifying supportive individuals through personal connections	Proposal for training programmes or recruitment policies for administrative staff to foster a change in mentality
1	Conducting individual conversations with team members	Proposal submitted to senior management to address this issue in the future
2	Implementing several minimal recommendations	Proposal submitted to senior management to address this issue in the future
3	Identifying supportive individuals through personal connections	Proposal of trainings or recruitment rules for administrative staff to change their mentaility
4	Conducting individual conversations with team members	Proposal for training programmes or recruitment policies for research staff to foster a change in mentality
6, 15	Making an attempt to minimise the administrative or other workload	Proposal submitted to senior management to address this issue in the future
7	none	Proposal for training programmes for research and administrative staff
8	Applying elements of modern uncertainty management methods	Proposal submitted to senior management to implement contemporary uncertainty management approaches.
13	Selecting an individual with the appropriate competencies and mindset	Proposal submitted to the programme owner regarding a reduction in documentation
14	none	Proposal submitted to the programme owner regarding a reduction in documentation
17	Introducing minimum procedures	Proposal submitted to senior management to address this issue in the future

We observe that barriers often necessitate changes in the system or environment that can only be implemented in the future and by departments, groups, or organisations outside the project team. These changes may be challenging or even nearly impossible to execute, but effective barrier management requires long-term planning and efforts to address systemic or inherent issues. Only through such an approach to barrier management can future university projects become significantly less risky.

For each barrier identified in a R&D project implemented at the university, we therefore propose the following steps:

1) To identify possibilities for immediate implementation.
2) To identify steps for the future, and for each such step to identify:
   a) the owner of the change,
   b) the degree of feasibility,

c) the time horizon within which the change might be implemented,
d) the stakeholders (both supportive and obstructive) associated with the change.

Each university should maintain a record of barrier management proposals arising from each project and utilise this record as input for developing its tactical and strategic decisions.

6. Conclusions

In this paper, we propose addressing barriers that hinder the creation of desired values in R&D projects implemented at universities. Barriers are defined as permanent obstacles or issues whose removal requires time and must be strategically planned for the future. The approach involves using lessons learned from each R&D project at universities to contribute to the stepwise elimination of these barriers. In the long term, this will reduce the risks associated with R&D projects and enhance the benefits they deliver to both the university and society.

A proposal for a barrier management system has been outlined. Naturally, further case studies are required to verify and refine the system to ensure its practical effectiveness.

Without such a system, problems related to R&D projects will not be mitigated but will recur repeatedly. This leads to a waste of money, effort, and enthusiasm, while also diminishing the societal benefits derived from R&D projects. For this reason, we hope that our research will contribute to enhancing the effectiveness of R&D activities at universities.

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FACTORS INFLUENCING CUSTOMERS' PURCHASING DECISIONS IN THE FOODSERVICE MARKET, TAKING INTO ACCOUNT THE MODERATING EFFECT OF CUSTOMERS' GENDER

Eugenia CZERNYSZEWICZ[1], Jolanta KRÓL[2*]

[1] Department of Management and Marketing, University of Life Sciences in Lublin;
eugenia.czernyszewicz@up.lublin.pl, ORCID: 0000-0003-2292-6819
[2] Department of Quality Assessment and Processing of Animal Products, University of Life Sciences in Lublin;
jolanta.krol@up.lublin.pl, ORCID: 0000-0002-6289-3153
* Correspondence author

Purpose: This study aims to determine the influence of selected attributes on customers' purchasing decisions in the food service market, considering the moderating effect of customers' gender.
Design/methodology/approach: The study was conducted in 2023 on a group of 262 economically active Generation Y people using catering establishments in one of the large cities of eastern Poland. The research tool was a survey questionnaire and the research method used was a diagnostic survey.
Findings: This study confirmed the moderating effect of gender on the frequency of attendance at different types of catering establishments, the identification of organoleptic characteristics that characterise a high-quality meal, the evaluation of the fulfilment of expectations regarding the food ordered, the perception of the manifestation of hygiene principles in the establishment, and the opinion that the maintenance of cleanliness in the establishment influences the quality of the meals offered.
Research limitations/implications: The survey was conducted among customers of catering establishments in only one major city in Poland. The respondents' characteristics included economically active people of Generation Y and their gender. Therefore, conducting similar research among people representing other generations, such as Generation Z or millennials, would be advisable. In addition, the scope of this research could be broadened to include issues related to the specific circumstances of eating in catering establishments, particular expectations regarding the organoleptic qualities of meals, and hygiene issues.
Practical implications: Investigating the key factors influencing customers' choice of catering establishments can help businesses understand customers' perceptions of key factors when choosing an establishment and create appropriate marketing strategies to attract existing and potential customers and outperform competition.
Social implications: Given the complex phenomenon of eating out, our study extends our understanding of the relative importance of criteria to customers when choosing a type of dining establishment.

Originality/value: The survey results are an important contribution to understanding the opinions of catering establishments and the purchasing behaviour of consumers using these establishments, particularly concerning perceptions of hygiene compliance and the quality of food served, the frequency and purpose of visits, and the type of catering establishments chosen.
Keywords: catering services, meal quality, hygiene, purchasing decisions, sex.
Category of the paper: research paper.

1. Introduction

Gastronomy is considered to be one of the oldest and most widespread service activities worldwide (Świątkowska et al., 2017; Zanetta et al., 2024). Every year, an increasing number of people use catering services, not only because of the lack of time to prepare meals, but also because of the lack of skills to prepare them, the greater involvement of women in the workforce, and the increase in income (Czernyszewicz et al., 2023; Rutkowska, Czarniecka-Skubina, 2015). It is important to note that the growth rate in eating out varies, with the fastest being recorded in the Asia-Pacific region (Edwards, 2019; Chowdhury, 2021). According to the National Restaurant Association (State of the Restaurant Industry Report, 2023), for 84% of consumers, going to a restaurant with family and friends is better use of time than cooking or cleaning. In their opinion, the amount of money spent eating out is similar to that spent at home. In Poland, about 67% of consumers enjoy dining out, spending on average about 4.2% of their total expenditure, up from only 1.4% as of 2000 (PMR Report, 2023). It should be noted that customers now have an increasing choice of dining establishments, from fast food to fine-dining restaurants (Dziadkowie, 2018; Zanetta et al., 2024). Street food is important in many countries (Shi and Nuangjamnong 2023; Kaewmahaphinyo et al.m 2020). Choosing an establishment depends on situational factors, that is, the dining occasion (celebrating special occasions, social gatherings, business meetings, quick meals, or leisure activities) (Kopacki, Bogacka, 2020; Gheribi, 2016).

Therefore, this study was undertaken to determine the influence of selected attributes on customers' purchasing decisions in the food service market, considering the moderating influence of customer gender. This research is an important contribution to understanding opinions about food service establishments and consumer purchasing behavior, particularly about perceptions of hygiene compliance and the quality of food served, as well as the type of food service establishments chosen, frequency and purpose of consumption.

2. Literature review

In addition to situational factors, many other factors related to menus, services, service conditions, and prices influence the choice of dining establishments. As indicated by many authors (Barrera-Barrera, 2023; Española, Janaban, 2024; Mathayomchan, Taecharungroj, 2020; Świętkowska et al., 2017; Zanetta et al., 2024), factors such as the quality of food (meals), quality of the service (e.g. empathy, professionalism, and responsiveness), service environment (e.g. décor, ambience), and value of money also influence the choice of a dining establishment. These factors are referred to as the 'big four attributes of a restaurant'. Other authors further point to menu variety, restaurant reputation, location, and promotion (Chua et al., 2020; Chiciudean et al., 2019; Medeiros, Salay, 2013). The relationship between these aspects is complex, as consumers make decisions based on trade-offs that balance costs and benefits, with attributes related to the quality of meals served and the quality of service being the most important in most studies (Mathayomchan, Taecharungroj, 2020; Majid et al., 2021). Customers perceive food quality to be at a high level when meals are made with fresh and good-quality ingredients, are tasty, and when there are a variety of menu items to choose from, and portions are large enough and aesthetically served. In turn, when assessing the quality of service, the key elements are the neat and clean appearance of the service staff, courtesy, attentiveness, product knowledge, accuracy, and speed of service. These attributes play a key role in shaping customer choices while influencing customer behaviour in different ways (Sari, Sunarti, 2023). Research has also pointed to other important factors affecting consumers' restaurant choices and experiences. For example, one can observe the role of 'healthy menus' (Jeong, Jang, 2015), plant-based menu options (Choi et al., 2022), environmentally conscious attitudes (Shin et al., 2018), the use of local products (Kim et al., 2020), and technological aspects (Teng, Chen, 2021). Factors influencing customers' restaurant choices vary depending on the occasion of eating out, as well as the type of dining establishments (Yrjölä et al., 2019). When planning special occasions (e.g. birthdays and anniversaries), restaurants are most often chosen, while other catering establishments are chosen to satisfy hunger. Consumer preferences when choosing a catering establishment should guide entrepreneurs in adapting to customer expectations. The customer evaluation of service quality is crucial for the survival and development of service businesses. With this in mind, the following research question was posed:

RQ1. What attributes influence customer purchasing decisions in the food service market?

Although many studies have been conducted on food service quality, few have addressed the moderating effect of gender on the relationship between service quality and customer satisfaction (Omar et al., 2016; Gasiorowska et al., 2023; Wolf, Zhang, 2016). Women have higher levels of service satisfaction than men (Omar et al., 2016). Gender is also an important

determinant of food preference (Gasiorowska et al., 2023). Hence, the following research questions were posed.

RQ2. Does gender moderate the choice of food outlet?

RQ3. Does sex influence opinions about the characteristics of a quality meal?

RQ4. Does gender influence judgements about the hygiene compliance of catering establishments and does cleanliness of the establishment influence judgements about the quality of meals on offer?

The answers to the above research questions are important in terms of customers' perceptions of the key factors in choosing an establishment and in developing marketing strategies to help attract and attract existing and potential customers to catering establishments.

3. Methods

The study was conducted in 2023 in the period May-August on a group of 262 economically active Generation Y people using catering establishments in one of the large cities in eastern Poland. The choice of the research group was based on the fact that Generation Y dominates the contemporary labour market. Above all, they prioritise personal development and devote time to their passions. They value their free time and are more willing to use entertainment and services, including catering, than other groups (Muszyńska, 2021). The majority of the respondents were women (53.4 %), while men were 46.6%.

The research tool was a survey questionnaire and the research method used was a diagnostic survey. The survey questionnaire consisted of 10 questions concerning the choice and frequency of visiting catering establishments and the reasons respondents chose a catering establishment. In addition, respondents were asked whether they paid attention to the quality of the meals they received, the characteristics of high-quality meals, the fulfilment of their expectations from the dishes they order, how compliance with the principles of hygiene in the premises manifests itself, whether the maintenance of cleanliness in the premises influences the quality of the meals offered, and whether the maintenance of hygiene principles by the staff influences their feelings of safety in the premises. The form mainly contained closed single-choice questions and three multiple-choice questions.

This study complied with the ethical standards set for all studies involving human subjects. Prior to entering the study, the participants were informed about the entity conducting the study, the purpose of the study, and how the data obtained in the study would be used. The participants automatically consented to participate in the study and voluntarily completed the questionnaire. Each survey participant was allowed to refuse to answer a specific question and withdraw from the survey at any time without providing a reason. Participants were assured of the anonymity and confidentiality of their responses.

The results of the study were analysed using the statistical programme IBM SPSS Statistics 29. Descriptive statistics (% of indications) were used for data analysis, and correlations between variables were analysed using Pearson's r correlation coefficients.

4. Results and discussion

The survey shows that customers visit food establishments most often 'several times a month' (45% of indications) and one in five (21%) 'once a month'. Of the respondents, 14.5% visited them 'once a week' and 16% visited them 'several times a week'. No respondents visit them 'daily'. Perhaps because of this frequency of catering establishments, customers most often chose restaurants (41.2% of indications) and pizzerias (39.7% of indications). Slightly less frequently, they visited cafés (33.6%) and bistros (25.25). Customers most often visit catering establishments to celebrate social events (41.6% of indications), and slightly less often to organise business meetings (28.2%) or family gatherings (24.4%). These results provide an answer to RQ1. In a study by Cieślik et al. (2010), out of 200 respondents only 29% declared that they visited catering establishments several times a month, while the answer 'once a month' was selected by 14% of respondents. The respondents most frequently visited bars and pizzerias. However, it should be noted that the period between Cieślik et al. (2010) study and our study was more than 10 years. Thus, based on this research, it is possible to identify changes in the preferences and behaviours of contemporary consumers in the market. In another study on consumer preferences (Grębowiec, 2010), more than two-thirds of the respondents declared that they used food services at least once a week, choosing pizzerias and restaurants most often, similar to the author's own research. In the author's subsequent study (Grębowiec, 2018), restaurants were slightly less popular, ranking third among the most frequently chosen catering establishments, after pizzerias and fast-food establishments. This may be due to the fact that more than 55% of the total number of respondents were young people aged up to 25 years. Jaciow and Wolny (2018) evaluating the catering market in 7 European countries (Finland, France, Germany, Poland, Romania, Slovakia and Hungary) found that the highest frequencý of use of catering services was declared by Romanians, i.e. less than 62% of respondents used catering services several times a week. In Finland, this percentage is less than 5%, and in Poland, it is 7.7%. On average, one in three respondents from France, Germany, Poland, Slovakia, and Hungary used catering services several times per month.

According to many authors (Mubarok et al., 2023; Ha, Jang, 2010; Alada, Castaño, 2020; Madjid et al., 2021; Zhong, Moon, 2020; Ebrahim et al., 2024; Grębowiec, 2018), the quality of a product is a factor that significantly influences customers' decisions to choose a catering establishment, which was also confirmed by our study's results. Of the respondents, 66% paid attention to the quality of the food they received and nearly 8% paid attention to it. According

to the respondents, a quality meal should be safe for health (43.5% of indications) and should also be characterised by an appropriate price (41.6% of indications) and organoleptic features (41.6% of indications). The nutritional value of the food consumed in catering establishments was less than one in three respondents (27.9%). Most respondents said that dishes were ordered rather than met their expectations in terms of freshness and preparation (47.7% and 11.8% of indications, respectively). According to Josiam and Monteiro (2004), the quality of the food served is influenced by seven quality attributes: taste, presentation of the dish, menu variety, wholesomeness, freshness, appropriate temperature, and safety. In a Polish study (Cieślik et al., 2014; Czernyszewicz, Wiśniewska, 2024; Grębowiec, 2018), respondents indicated that quality food is distinguished by adequate nutritional value, taste, freshness, as well as safety. In addition, despite cultural differences, consumers from Asian countries have similar attributes of quality, that is, the taste of the food, the variety of the menu, the aesthetics of presentation, and freshness (Carvache-Franco et al., 2021; Sari, Sunarti, 2024). Only serving quality products can satisfy customers and, consequently, be loyal (Mubarok et al., 2023; Alada, Castaño, 2020; Talukder, Kumar, 2024; Kaewmahaphinyo et al., 2020). A study of five fast-food restaurant customers in the Philippines (Alada, Castaño, 2020) found that food quality ($\beta = 0.145$, $p < 0.05$), food safety ($\beta = 0.125$, $p < 0.05$), and ambience ($\beta = 0.471$, $p < 0.05$) had a significant impact on customers' positive emotions, whereas only service quality ($\beta = -0.119$, $p < 0.05$) and ambience ($\beta = 0.141$, $p < 0.05$) had a significant impact on customers' negative emotions. In contrast, Majid et al. (2021) found that food quality ($r = .52$ $p < 0.001$), service quality ($r = .71$ $p < 0.001$), and price ($r = .60$ $p < 0.001$) were positively related to customer satisfaction. In several studies (Chua et al., 2020; Kwun, Oh, 2004; Cieślik et al., 2014; Majid et al., 2021), price was perceived as the most important criterion for customers to choose a food outlet. Chua et al. (2020) showed that the level of importance of price depended on the occasion of eating out (social gatherings, business meetings, celebrations, quick meals). Regardless of the type of establishment (full-service, quick-casual, and fast-food), price was most important when choosing an establishment for quick meal/convenience, as well as for socialising. The authors suggest that when there is a large choice of restaurant options with similar product or service offerings, customers tend to rely on price in their decision-making.

Hygiene is also an important criterion in the establishment of dining (Czernyszewicz et al., 2023; Alada, Castaño, 2020; Española, Janaban, 2024). In our study, respondents indicated that hygiene rules were rather or definitely observed in the premises where they were most frequent (40.1% and 26.7% of indications, respectively). According to the respondents, compliance with hygiene rules manifests itself primarily in the cleanliness of the premises (82.8% of indications) and in the cleanliness of the staff's clothes (32.1% of indications). One in five respondents indicated the cleanliness of tables (21%) and kitchenware (20.2%). Cleanliness outside of the premises was indicated by less than one in ten respondents (7.3%), and the hygienic state of the toilets was indicated by only 3.1%. Customers overwhelmingly associated the cleanliness of the premises with the quality of the meals on offer (43.9% rather yes and 33.6% definitely yes),

and the maintenance of hygiene rules by the staff with the feeling of safety in the premises (52.7% rather yes, 31.3% definitely yes). The results of a study conducted by Cieślik et al. (2014) showed that 68% of the respondents believed that adherence to hygiene rules influenced the quality of food they received. Customers primarily paid attention to the cleanliness of the premises, personal hygiene, and presentation of the waiters. The cleanliness of restaurant interiors, utensils, and staff has been identified in many studies (Barber et al., 2011; Liu, Lee, 2018; Moreira Junior et al., 2019) as significant factors in consumers' choice of establishment. Barber et al. (2011) showed significant correlations between service quality attributes in the physical environment and returns to the premises. Liu and Lee (2018) found that restaurant cleanliness practices have a direct impact on customers' satisfaction, their experience of the restaurant, and consequently, their intention to visit again. According to Fiiwe et al. (2023), the focus should be on building lasting relationships with customers, because retaining existing customers is more profitable than attracting new ones.

The correlation analysis showed that the gender of the respondents was correlated with attendance at catering establishments, the indication of organoleptic characteristics that characterise a high-quality meal, the evaluation of the fulfilment of expectations regarding the ordered dishes, the perception of manifestations of hygiene principles in the establishment, in terms of the cleanliness of the tables, the cleanliness of the kitchenware, the cleanliness of the staff's clothes, and the opinion that maintenance of cleanliness in the establishment influences the quality of meals offered (Table 1). The significant correlations shown allow research questions RQ2, RQ3, and RQ4 to be answered affirmatively.

Table 1.
Significant correlations between respondents' gender and surveyed issues regarding eating establishments based on Pearson's correlation coefficient (N = 262)

Question number	Pearson correlation coefficient
1 Attendance at eating establishments:	
Restaurant	-0.129*
Bistro	0.234**
Café	-0.534**
Pizzeria	0.494**
5 Characteristics of a quality meal:	
Organoleptic characteristics	-0.122*
6. Does the food ordered meet expectations?	0.173**
8. How is the hygiene of the catering establishment demonstrated:	
Cleanliness of tables	0.158*
Cleanliness of tableware	-0.165**
Cleanliness of staff attire	-0.248**
9. Does the cleanliness of the establishment affect the quality of the food offered?	0.153*

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

Source: Own study.

This study found that women were significantly more likely to visit restaurants and cafés, whereas men were more likely to visit pizzerias and bistros (Figure 1).

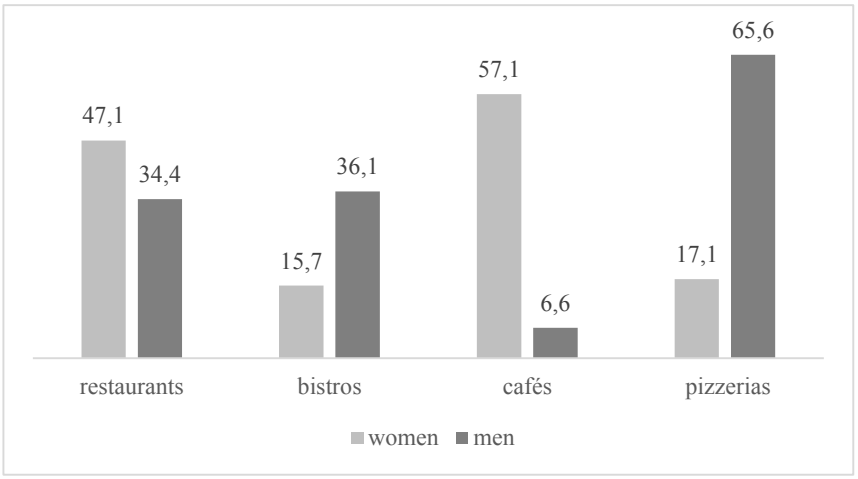

Figure 1. Attendance at catering establishments by gender-differentiated respondents (% of indications)
Source: Own study.

The gender of the respondents was significantly correlated with the indication of the organoleptic characteristics that characterise a quality meal (Figure 2). The other characteristics, despite different evaluations, were not significantly correlated with respondents' gender. The organoleptic features of meals as characteristics of a high-quality meal consumed in astronomical establishments were significantly more frequently indicated by women than by men. In contrast, when indicating the characteristics of a high-quality meal, men were more likely to indicate the nutritional value and price of the meal. These results allowed us to answer RQ3 affirmatively. Gender also had a moderating effect on the relationship between perceived food quality and price ($p < 0.05$) in a study of restaurant customers in China (Zhong, Moon, 2020). Female customers were less influenced by price than were male customers. Ma et al. (2014) found that female customers tended to have higher expectations for most food quality attributes than male customers, especially in terms of taste, presentation, and menu variety, whereas male customers placed more emphasis on portion size.

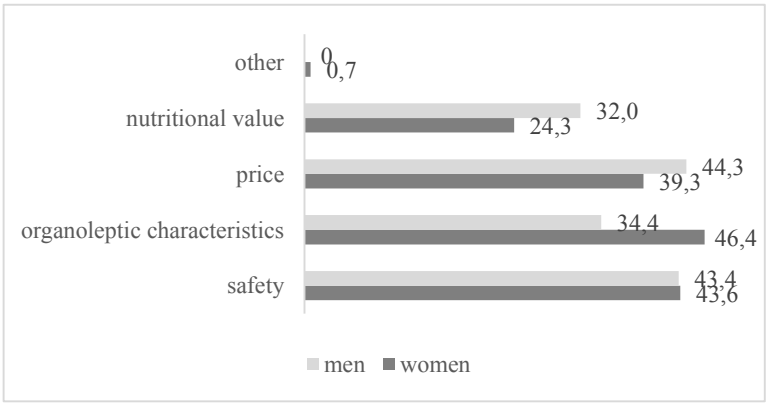

Figure 2. Women's and men's opinions on the characteristics of a quality meal (% indications).
Source: Own study.

The gender of the respondents was also significantly correlated with the evaluation of fulfilment of the expectations of the ordered dishes (Figure 3). Men were significantly more likely than women to state that the ordered dish definitely met their expectations, while women were more likely to indicate that it 'rather not' met their expectations. These results are consistent with those of Gasiorowska et al. (2023) and Wolf and Zhang (2016), regarding the moderating effect of gender on the relationship between service quality and customer satisfaction. In contrast, the view of Omar et al. (2016) is that women show higher levels of satisfaction with food services than men. Gender is also an important determinant of food preference (Gasiorowska et al., 2023). Women have been shown to have a greater preference for items perceived as feminine (e.g. salad, fruit, vegetables, and seafood), whereas men have a greater preference for masculine items (e.g. steak and burger).

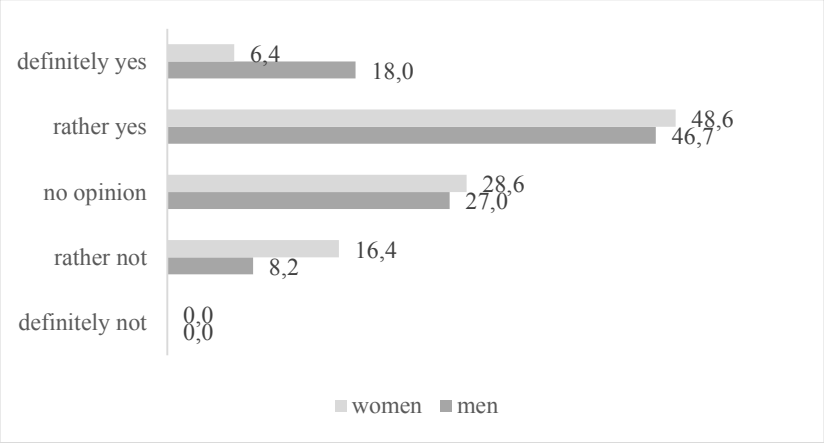

Figure 3. Opinions on the fulfilment of expectations from ordered dishes in catering establishments (% of indications).

Source: Own study.

The gender of the respondents was significantly correlated with their perception of the selected manifestations of hygiene in catering establishments (Figure 4). Women were significantly more likely to perceive the cleanliness of the kitchenware and staff clothing as manifestations of hygiene compliance, while men were more likely to perceive the cleanliness of the tables. In addition, men were more likely than women to consider the hygienic state of toilets and cleanliness inside the premises, which is consistent with other studies (Ma et al., 2014). In a study by Mason et al. (2018), the cleanliness of the establishment, along with price and portion size, was one of the most important criteria for both genders in choosing a fast-food restaurant. Food quality appears to be a more important restaurant selection criterion for men than women. Castillo and Del Río (2023) showed a stronger association between satisfaction with quality and revisiting a restaurant for women (0.599) compared to men (0.437).

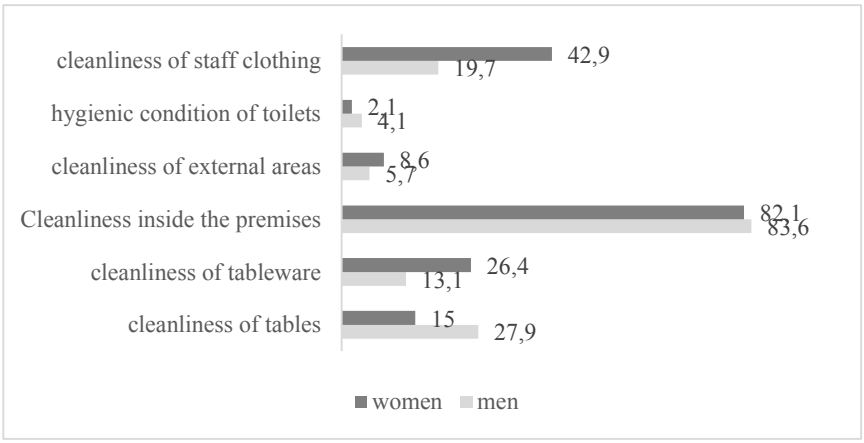

Figure 4. Opinions on manifestations of hygiene compliance in catering establishments (% of indications).

Source: Own study.

The gender of the respondents was also correlated with the opinion that the maintenance of cleanliness in the establishment influences the quality of the meals offered (Figure 5). Men were significantly more likely to say that it 'definitely does', whereas women were significantly more likely to have no opinion on the subject. These results indicate a positive response to RQ4. The results obtained are consistent with the study by Chow et al. (2007), in which male customers tended to show higher expectations of service quality, including the cleanliness of the premises, compared to women. Zhong and Moon (2020) obtained similar relationships, with service quality having a stronger effect on male customers than on female customers ($p < 0.1$). Manal et al. (2024) obtained significant correlations ($r = 0.118$, $p = 0.001 < 0.05$), indicating that service quality influenced customers' satisfaction with food quality and restaurant service. In a study conducted in Pakistan's restaurant industry (Murad, Ali, 2015), respondents indicated that service had a definite impact on customer satisfaction. More than 41% of the respondents were not satisfied with the waiters, who felt too busy responding to customers' needs and desires.

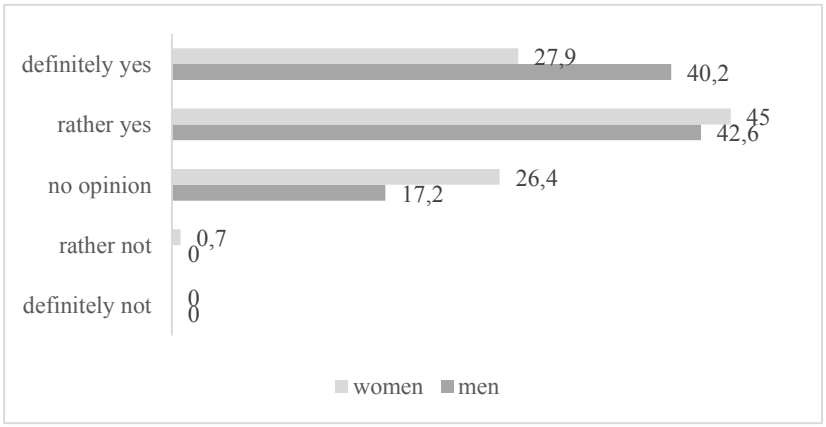

Figure 5. Opinions on the impact of keeping the premises clean on the quality of the meals offered (% of indications).

Source: Own study.

5. Conclusions

This study aims to determine the influence of selected attributes on customers' purchasing decisions in the catering market, considering the moderating influence of customers' gender. The results of the study confirmed the moderating influence of gender on the frequency of attendance at different types of catering establishments, identification of organoleptic attributes that characterise a quality meal, assessment of the fulfilment of expectations regarding the dishes ordered, perception of the manifestation of hygiene principles in the establishment, and opinion that the maintenance of cleanliness in the establishment influences the quality of the meals offered.

This study was conducted among customers of catering establishments in only one large city in Poland. The characteristics of the respondents included economically active people of Generation Y and their gender. Therefore, it would be advisable to conduct similar research among people representing other generations, such as Generation Z or Millennials. In addition, the scope of the research could be broadened to include issues related to the specific circumstances of eating out in catering establishments, detailed expectations regarding the organoleptic qualities of meals, and hygiene issues in the establishment.

Investigating the key factors influencing customers' choice of eating out establishments can not only help entrepreneurs understand customers' perceptions of the key factors in choosing an establishment but also create appropriate marketing strategies to attract existing and potential customers and to outperform the competition. Given the complex phenomenon of eating out, our study expands the understanding of the relative importance of customer criteria in choosing the type of dining establishment.

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SUSTAINABLE BRAND EQUITY AS A NEW AREA IN BRAND MANAGEMENT AND MARKETING

Hanna GÓRSKA-WARSEWICZ

Management Institute, Warsaw University of Life Sciences; hanna_gorska-warsewicz@sggw.edu.pl,
ORCID: 0000-0002-5110-7583

Purpose: Sustainable branding is an important research area in marketing and management. Therefore, the purpose of this study was to identify the state of research in the field of sustainable brand equity (SuBE) using bibliometric analysis. Particular attention was paid to identifying subject areas.
Design/methodology/approach: The design, compilation, analysis, visualization, and interpretation phases of a bibliometric analysis were all used. The Scopus database provided 340 publications overall after a thorough search. In the examined research, science mapping and performance indicators pertaining to publications and citations were employed.
Findings: Since 1997, when the first article on HBE was released, 340 publications indexed in the Scopus database have been published. These publications have achieved 5671 citations with an h-index of 40. The country with the most affiliations was the United States, followed by India and China. Using the minimum number of documents at level 3, 36 countries were identified in 8 clusters. The SuBE-related studies provided 1,371 keywords in 10 clusters related to brand creation, brand management, and competitiveness in the context of sustainability; green and circular economies; consumer behavior and social media; communication and consumer decisions; and modern research methods in marketing.
Research limitations/implications: SuBE was analysed in general, indicating sustainable management and marketing. First, there is the diversity of regional and cultural contexts. The influence of culture, local economic conditions, and the level of environmental awareness can vary from region to region and was not analysed. Second, time frames were also not analysed.
Practical implications: Theoretical and practical implications for SuBE were formulated. The theoretical implications include the need to integrate theories from marketing, management, sustainability, and communications to understand how brands can meet consumer expectations and achieve environmental goals. As practical implications, companies must include sustainability as a central element of their branding strategy to build lasting relationships with environmentally conscious consumers.
Originality/value: There were no studies demonstrating the present level of development of this field of study; hence our bibliometric analysis study on SuBE closes a research gap. The originality of this study is in the identification of clusters that represent current research areas in the field of SuBE.
Keywords: sustainable brand equity, sustainable brand, sustainable branding, sustainable management, bibliometric analysis.
Category of the paper: literature review.

1. Introduction

Sustainable branding is an important research area in marketing and management (Kaur, Gupta, 2024; Kaur, Monisha, 2023; Meštrović, 2023; Muchenje et al., 2023; Ryals, Macdonald, 2015; Swaroop, Gade, 2023). Both marketing and sustainable branding are related to advancing sustainability through various complementary approaches. While sustainable marketing conveys these ideals to customers, sustainable branding supplies the identity and values (Kumar, Christodoulopoulou, 2014; Popescu et al., 2023). In this aspect, brand loyalty and responsible consumer behavior are subsequently fostered by sustainable marketing, which improves brand image (Jia et al., 2023; Kumar, Christodoulopoulou, 2014). Sustainable branding initiatives can boost customer happiness and engagement through sustainable marketing. This is especially true in industries like sustainable food production, where it is essential to raise awareness and improve the perception of sustainability brands (Franco, Cicatiello, 2018). Through the incorporation of sustainability principles into business operations, creative management techniques, strategic marketing, and effective communication, sustainable branding and sustainable management are closely related. Businesses may create powerful, long-lasting brands that support a more sustainable future and provide them a competitive edge in the market by coordinating these factors (Foroudi, Palazzo, 2020).

The issue of brand equity is widely analyzed in the literature. This includes general aspects (Almestarihi et al., 2021; Rojas-Lamorena et al., 2022; Dropulić et al., 2022) as well as various product and service sectors (Juga et al., 2018; Hazée et al., 2017; Çifci et al., 2016; Dwivedi, Merrilees, 2013; Andéhn et al., 2014; Florek, Kavaratzis, 2014; Górska-Warsewicz, 2020; De Heer, 2020; Gupta et al., 2019; Vijay MallikRaj et al., 2017). Various aspects, including brand equity strategies in the context of customer-brand relationships (Hunt, 2019), the impact of brand strategies on organizational brand equity (Wei, 2022), national brands' equity over store brands (Sethuraman, 2003), and brand equity in relation to employer branding (Theurer et al., 2018), were analyzed. The importance of customer-based brand equity for global brands (Atilgan et al., 2009) and green brand equity for different product categories and various industries (Butt et al., 2017; Dolatabadi et al., 2016; Ho et al., 2019; Ishaq, 2020; Qadir et al., 2021) was also indicated.

A gap in research on sustainable brand equity has been identified due to studies in the form of bibliometric analyses and systematic literature reviews on SuBE. However, there are other studies on green brand equity. Such brand equity has been shown to be linked to Such brand equity has been shown to be linked to greenwashing (Akturan, 2018; Avcilar, Demirgünes, 2016), competitive advantage (Bekk et al., 2016), drivers of green brand equity (Chen, 2010; Deniz, Onder, 2017), and the importance of consumer-based green brand equity (Khandelwal et al., 2019).

Based on the above considerations, the purpose of this study was to identify the state of research in the field of SuBE using bibliometric analysis. Particular attention was paid to identifying subject areas. Three research questions were prepared:

1. What is the state of development of the field of SuBE?
2. Which countries and authors are relevant to the topic on SuBE?
3. What thematic areas are being explored in relation to SuBE?

2. Literature review

The issue of sustainable brands has been studied extensively in the literature. Sustainable brands integrate economic, social, and environmental concerns into their brand management and commercial operations. This all-encompassing strategy guarantees that the brand prioritizes not just financial gain but also the well-being of the environment and society (Fallström et al., 2018; Foroudi, Palazzo, 2020). In this concept, the identity of organizations and their brands reflects a commitment to sustainability, linking management methods to the Sustainable Development Goals (SDGs) (Caldana et al., 2022). This is because sustainable branding extends above standard brand management by taking into account wider viewpoints, including corporate social responsibility, the circular economy, and environmental ecosystems (Foroudi, Palazzo, 2020). Effective implementation of sustainable branding is demonstrated by best practices from a variety of industries (Fallström et al., 2018; Foroudi, Palazzo, 2020).

Sustainable branding involves integrating brand identity and operations with environmentally friendly values to create interest in eco-aware customers and support a sustainable future (Surmanidze et al., 2024). In this concept, to gain consumers' trust and loyalty, sustainable brands frequently highlight ethical behavior, transparency, and environmental responsibility in their marketing campaigns (Eyada, 2024; Gutiérrez et al., 2024). At the same time, connecting with customers and setting the business apart in a crowded market require effective communication of sustainability initiatives (Caballero-Castaneda et al., 2021; Surmanidze et al., 2024). Brands that effectively promote their sustainability initiatives can observe a rise in consumer satisfaction, loyalty, and willingness to pay (Franco, Cicatiello, 2018). Additionally, long-term business success, competitive advantage, and improved company image can all be attributed to sustainable branding (Fallström et al., 2018; Saraiva, 2022).

Sustainable branding is closely related to sustainable marketing, which requires a comprehensive strategy that takes into account the entire life cycle of a product and its broader environmental and social impact (Kaur, Gupta, 2024; Kaur, Monisha, 2023). In this area, designing, advertising, selling, and distributing goods in a way that has the least negative impact on the environment is known as sustainable marketing. Using eco-friendly raw materials,

packaging, and procedures are also part of these activities (Kaur, Gupta, 2024; Ryals, Macdonald, 2015). It emphasizes the entire production process, from sourcing raw materials to disposal, ensuring that each step is environmentally sustainable (Kaur, Gupta, 2024; Kaur, Monisha, 2023; Swaroop, Gade, 2023). Sustainable branding encompasses ethical issues, ensuring that marketing activities positively impact society and respect the needs of future generations (Meštrović, 2023; Ryals, Macdonald, 2015; Swaroop, Gade, 2023). At the same time, sustainable marketing tactics must be profitable and competitive to guarantee long-term corporate success while preserving sustainability standards (Muchenje et al., 2023).

Sustainable brand equity combines traditional brand equity (Aaker, 1991; Keller, 1993) with sustainability initiatives to demonstrate a brand's dedication to social and environmental responsibility (Kara et al., 2024). This idea emphasizes how crucial environmental and non-financial activities are in influencing consumer attitudes and brand value. Environmental and non-financial activities have an impact on a company's sustainable brand equity. Businesses use social responsibility and green efforts to show customers how committed they are to sustainability. Compared to other brands, this strategy aids in creating a competitive position in sustainability (Kara et al., 2024). Sustainable brand equity is perceived as the consumer perceptions of a brand's sustainability efforts. In this concept, customer trust, satisfaction, and loyalty are influenced by brand identification, brand awareness, physical quality, lifestyle congruence, staff behavior, and ideal self-congruence (Dananjoyo, Udin, 2023). Additionally, by increasing market share, creating barriers to entry for competitors, expanding production and market, offering premium pricing, attracting top talent, guaranteeing customer loyalty, and fostering innovation, sustainable brand equity improves the overall success of the company (Veselinova, Samonikov, 2018).

3. Methodology

The purpose of this study was to identify the state of research in the field of SuBE using bibliometric analysis. Particular attention was paid to identifying thematic areas. Bibliometric analyses are becoming increasingly common to show the development of a specific field over a specific time period (Donthu et al., 2021; Ellegaard, 2018; Gan et al., 2022; Moral-Muñoz et al., 2020). Five steps of this bibliometric process were applied with design, compilation, analysis, visualization, and interpretation (Zupic, Čater, 2015).

In the first stage, the study was designed, the research gap was identified, and the research questions were formulated. In the second stage, the Scopus database was searched. The search was carried out at the end of December, using the state as of December 31, 2024. The search path employed was as follows: (TITLE-ABS-KEY ("brand equity") AND TITLE-ABS-KEY

(sustainable) or TITLE-ABS-KEY (sustainability) AND (PUBYEAR > 1996 AND PUBYEAR < 2025) (LIMIT-TO (LANGUAGE, *"English"*)).

Science mapping and performance analysis were part of the third step related to data analysis. Publication-related indicators, including the number of publications and lead authors, and citation-related indicators, including the total number of citations and the average number of citations annually, were used (Donthu et al., 2021). The bibliometric analysis examined the subjects discussed in SuBE and Scopus publications by source. The bibliometric counting method of science mapping included charts that display the number of items and groups. The authors who published the most were identified. By mapping the bibliometric counts of SuBE article authors and co-authors, the number of clusters was ascertained. This analysis presents the countries with the highest number of affiliations. Through keyword analysis, the total number of keywords and the order of the most popular terms were disclosed. Using mapping techniques, a study of keyword co-occurrence was discovered. A counting approach covered at least three keyword occurrences. VOSviewer (Nees Jan van Eck and Ludo Waltman, Leiden University, version 1.6.17) was used to prepare the co-occurrence analysis and bibliometric counting. A summary of the answers to the research questions was given in the discussion section, which brings the bibliometric study to a conclusion.

4. Results

4.1. Number of SuBE publications and citations

There were 340 publications on SuBE at the end of 2024. One study was published between 1997 and 2000, 17 studies in 2001-2010, 150 studies in 2011-2020, and 170 in 2021-2024, with an average of 12.1 publications per year (Figure 1).

The article *Chocolates El Rey: Industrial modernization and export strategy* is the first publication indexed in the Scopus database (Dominguez, Cirigliano, 1997). The article focuses on the issue of sustainable competitive advantage in developing countries, taking Chocolates El Rey and the Venezuelan cocoa industry as an example. Two issues were analyzed: export strategy and brand value. Under export strategy, ways to differentiate the company from its competitors, market segments planned to be served, and types of distribution channels were analyzed. Under brand value development, possibilities for improving the negative image of goods from underdeveloped countries were studied.

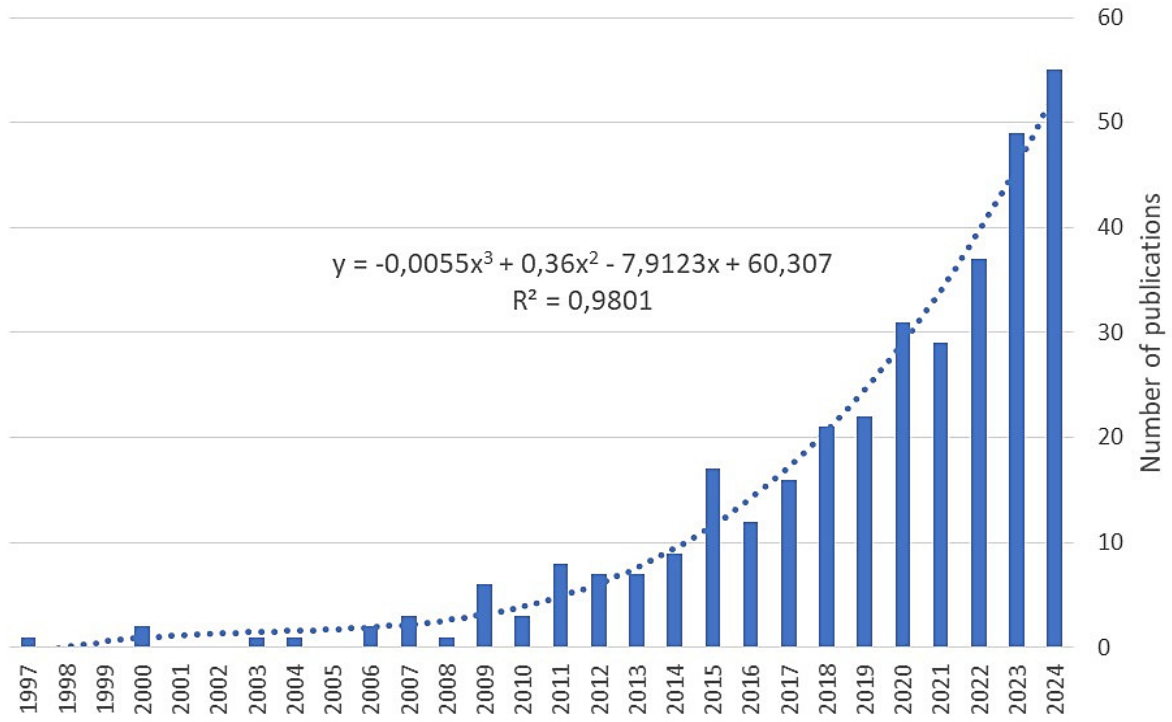

Figure 1. Number of SuBE publications between 1997 and 2024.

Source: Scopus data with trend line, as of 31.12.2024.

The total number of citations of the SuBE studies amounted to 5671. The average annual number of citations equals 202.5. Of the 340 SuBE publications, 250 were cited with an h-index of 40 and a citation count of 5,720. The number of citations was 74 by 2010, 1749 between 2011 and 2020, and 3848 between 2021 and 2024 (Figure 2).

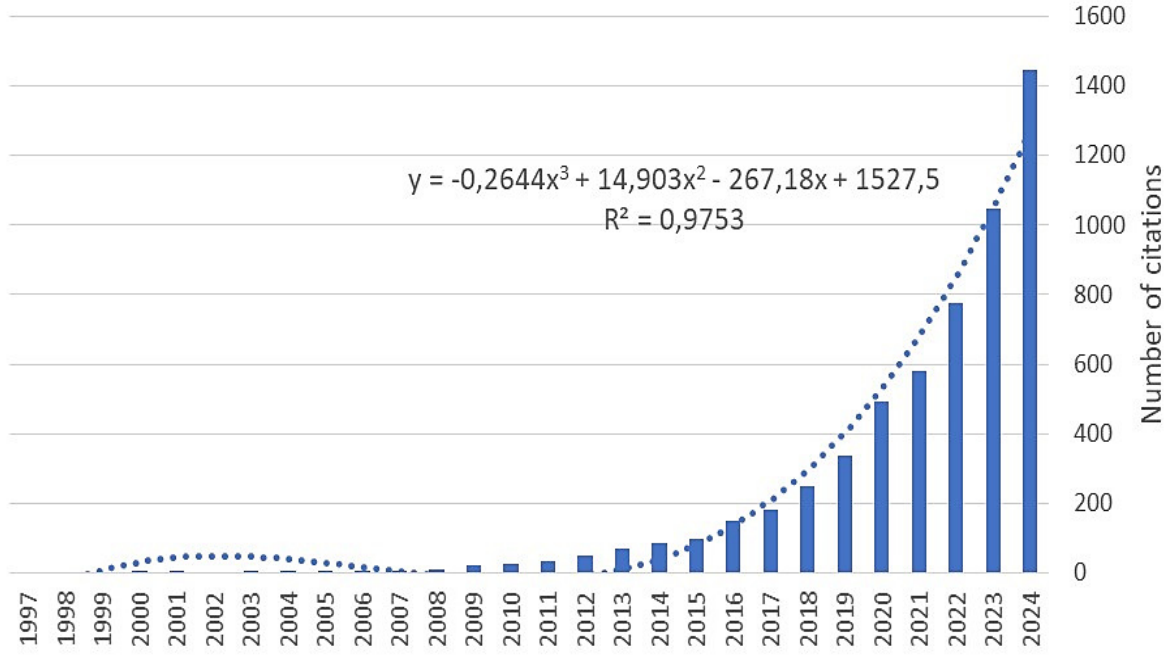

Figure 2. Number of SuBE citations between 1997 and 2024.

Source: Scopus data with trend line, as of 31.12.2024.

The highest number of citations was noticed for the article *Remanufactured products in closed-loop supply chains for consumer goods* published in 2015 in the Production and Operations Management (Abbey et al., 2015). This article was cited 292 times (Table 1). The study examined consumer perceptions of remanufactured consumer products in closed supply chains. It found that discounting had a positive effect on the attractiveness of remanufactured products. Manipulation of brand equity proved to be less important to consumers than perceptions of the quality of remanufactured products.

Table 1.
Most cited SuBE publications[*]

No.	Title	Authors	Source	Year	Number of citations
1.	Remanufactured products in closed-loop supply chains for consumer goods	Abbey, J.D., Meloy, M.G., Guide, V.D.R., Atalay, S.	Production and Operations Management, 24(3), pp. 488-503	2015	292
2.	Young consumers' insights on brand equity: Effects of brand association, brand loyalty, brand awareness, and brand image	Sasmita, J., Mohd Suki, N.	International Journal of Retail and Distribution Management, 43(3), pp. 276-292	2015	206
3.	Current issue in tourism: The authentic tourist	Yeoman, I., Brass, D., McMahon-Beattie, U.	Tourism Management, 28(4), pp. 1128-1138	2007	195
4.	Towards an identity-based brand equity model	Burmann, C., Jost-Benz, M., Riley, N.	Journal of Business Research, 62(3), pp. 390-397	2009	183
5.	Investigating the antecedents of green brand equity: A sustainable development perspective	Kang, S., Hur, W.-M.	Corporate Social Responsibility and Environmental Management, 19(5), pp. 306-316	2012	161
6.	Internal brand factors driving successful financial services brands	De Chernatony, L., Cottam, S.	European Journal of Marketing, 40(5-6), pp. 611-633	2006	158
7.	"When experience matters": Building and measuring hotel brand equity: The customers' perspective	Kam Fung, K., King, C.	International Journal of Contemporary Hospitality Management, 22(5), pp. 589-608	2010	149
8.	A consumer-perceived consumer-based brand equity scale	Baalbaki, S., Guzmán, F.	Journal of Brand Management, 23(3), pp. 229-251	2016	148
9.	The effect of sensory brand experience and involvement on brand equity directly and indirectly through consumer brand engagement	Hepola, J., Karjaluoto, H., Hintikka, A.	Journal of Product and Brand Management, 26(3), pp. 282-293	2017	141
10.	How CSR reputation, sustainability signals, and country-of-origin sustainability reputation contribute to corporate brand performance: An exploratory study	Cowan, K., Guzman, F.	Journal of Business Research, 117, pp. 683-693	2020	129

[*] 10 publications with the highest number of citations.

Source: Scopus data, as of 31.12.2024.

4.2. Subject areas and authors of DigBE publications

The largest number of publications was classified in the subject area of *business, management, and accounting* (above 200) (Table 2). In second place was the category of *social sciences* with the number of publications of 109. The following subject areas qualified between 50 and 100 publications. These are the following subject areas: *environmental science, economics, econometrics, and finance, energy,* and *computer science. Engineering* is the next highest ranking with 29 publications, while categories such as *decision sciences, arts and humanities, mathematics, and agricultural and biological sciences* included between 10 and 20 publications. The remaining subject areas included fewer than 10 publications.

Table 2.
Subject areas of SuBE publications

Subject areas	**Frequencies**
Business, management, and accounting	225
Social sciences	109
Environmental Science	83
Economics, econometrics, and finance	75
Energy	56
Computer science	55
Engineering	29
Decision sciences	16
Arts and humanities	12
Mathematics	11
Agricultural and biological sciences	10
Psychology	7
Multidisciplinary	5

Each publication can be classified in the Scopus database into several subject areas.

Source: Scopus data, as of 31.12.2024.

The authors of the largest number of publications were Gil-Saura I., Ruiz-Molina M.E., and Marín-García A., who published 12, nine, and seven studies, respectively. The authors of five publications were Kim K.H. and Kantabutra S., while four publications were published by Bordian M. Three studies each were published by Šerić M., Winit W., Moise M.S., Kim J., and Ishaq, M.I. The authors of two publications were Yu P., Tantawi P., Sun Y., Shen C.C., Shanti J., Saurage-Altenloh S., Rodrigues S., Rehman M., Randall P.M., Puriwat W., Powell S.M., Park J.W., Nilasari I., Nikanloo N., Narayanan S., Moslehpour M., Morrone D., Mohiuddin M., Mohemi M., Martins J., Mamun A.A., Majeed M., Lu W., Lavorata L., Kwon J., Kristanti M.M., Krishnapillai G., Kitchen P.J., Jung H.S., Jones J., Jeon B.J., Hur W.M., Huertas-Garcia R., Hayat N., Guzman F., Gupta S., Gonçalves R., Ebrahim Hosseini S., Di Maria E., Correia R., Chan C.S., Branco F., Berenguer-Contri G., Ahn J., Abazari Y.

4.3. Countries and sources of SuBE publications

The largest number of authors were affiliated in the United States (Table 3). The next country in the ranking was India, while more than 20 publications were affiliated with countries such as China, the United Kingdom, and South Korea. There were 10-20 authors or co-authors from Malaysia, Indonesia, Thailand, Taiwan, Australia, Pakistan, and Italy.

Table 3.
Affiliate countries of SuBE publications

Countries	Frequencies
United States	56
India	38
China	28
United Kingdom	26
South Korea	22
Malaysia	19
Indonesia	15
Thailand	15
Taiwan	14
Australia	12
Pakistan	11
Italy	10
Portugal	8
France	8
Turkey	8
South Africa	7
Iran	7
Canada	6
Vietnam	5
Poland	5
Nigeria	5
Brazil	5
Japan	5

does not include countries that have been affiliated 4 times or less.

Source: Scopus data, as of 31.12.2024b.

The bibliographic coupling identified 68 countries. Using the minimum number of documents at level 3, 36 countries were identified in 8 clusters (Figure 3). Eight countries (Hong Kong, India, Peru, Poland, Portugal, South Korea, Spain, and Viet Nam) were classified into the first cluster, five countries (Indonesia, Japan, Malaysia, Pakistan, and Saudi Arabia) in Cluster No. 2, five countries (Netherlands, Switzerland, Thailand, the United Kingdom, and the United States) in Cluster No. 3, five countries (Ghana, Nigeria, South Africa, Turkey, and Zimbabwe) in clusters No. 4, four countries (Australia, Canada, Germany, and Sweden) in cluster No. 5, four countries (China, Iran, Philippines, and Taiwan) in cluster No. 6, three countries (Brazil, France, and Italy) in cluster No. 7, and two countries (Finland and Romania) in Cluster No. 8.

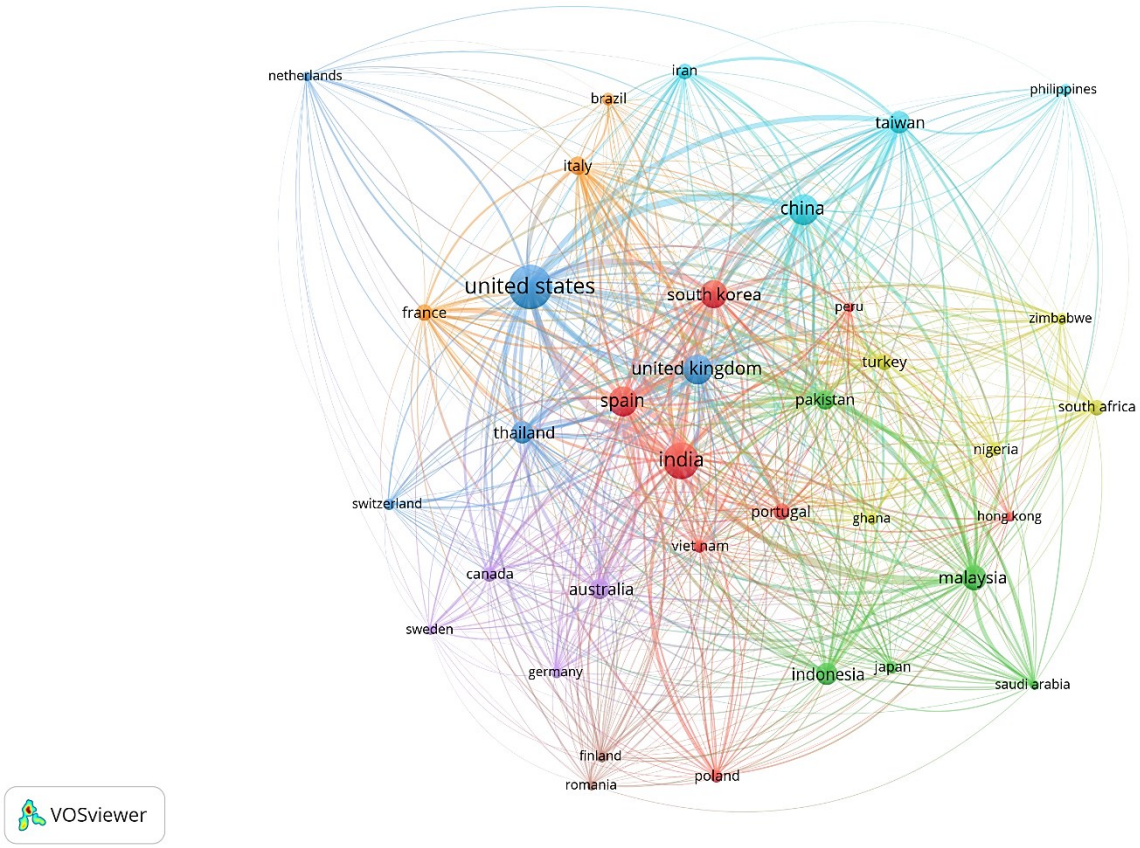

Figure 3. Bibliometric coupling of countries for SuBE publications.

Source: VOSviewer based on Scopus data, as of 31.12.2024.

Publications on SuBE were mainly published as articles in journals (236 studies), book chapters (52), conference papers (19), and reviews (16). Other document types were as follows: conference reviews (7), notes (4), books (3), editorials (2), and erratum (1).

4.4. Thematic areas of DigBE publications

The SuBE-related studies indexed in the Scopus database provided 1,371 keywords. The two phrases *brand equity* and *sustainability* appeared in the largest number of publications (Table 4). Other keywords such *as sustainable development, equity,* and *marketing* appeared in 30-40 publications. The keywords *corporate social responsibility, perception, green brand equity, brand loyalty, brand awareness, green marketing, branding, brand image, brand management*, *social media, consumption behavior,* and *consumer behavior* appeared in 10-20 publications. Other keywords appeared less frequently.

Analysis of keyword co-occurrence discovered ten clusters using the full counting approach with the minimum number of occurrences of three (Figure 4).

Cluster No. 1 (in red) can be titled *Shaping brand and competitiveness.* It contains 28 keywords such as *brand equity, brand experience, brand image, branding, competition, competitive advantage, corporate branding, corporate image, corporate reputation, csr, customer-based brand equity, green marketing, innovation, marketing, marketing mix,*

marketing strategy, product design, sales, social responsibility, sustainable competitive advantage, and *sustainable tourism.* Publication topics in this cluster focus on the theoretical and practical foundations of brand building and management. Brand equity is analyzed through brand awareness, perceived quality, brand loyalty, and brand associations. Brand image and brand experience, on the other hand, point to the importance of consumers' emotions and perceptions in creating brand relationships. In addition, strategies for shaping competitive advantage through innovation, corporate social responsibility, and strategic planning were analyzed.

Table 4.
The most frequently occurring keywords in SuBE publications

Keywords	**Frequencies**
Brand equity	118
Sustainability	86
Sustainable development	38
Equity	38
Marketing	36
Corporate social responsibility	19
Perception	17
Green brand equity	17
Brand loyalty	17
Brand awareness	16
Green marketing	14
Branding	14
Brand image	13
Brand management	11
Social media	10
Consumption behavior	10
Consumer behavior	10
Perceived quality	9
Decision making	9
Customer equity	9
Commerce	8
China	8
Trust	7
Tourism	7
Strategic approach	7
Satisfaction	7
Purchase intention	7
Loyalty	7
Innovation	7
Environmental sustainability	7
Customer satisfaction	7
CSR	7
Value co-creation	6
Tourist destination	6
Sustainable competitive advantage	6
Green brand image	6
Business	6

Table does not include keywords that have been mentioned 5 times or less.

Source: Scopus data, as of 31.12.2024.

Cluster No. 2 (in dark green) may have been titled *Brand management with special emphasis on tourism services*. It includes 20 keywords such as *brand, brand attachment, brand personality, customer satisfaction, destination brand, ecotourism, knowledge, loyalty, management practice, profitability, public attitude, tourism, tourism management, tourist behavior,* and *tourist destination.* The issues of brand management in tourism point to many aspects, including building loyalty to the destination, creating a tourist image, or the impact of marketing activities on tourists' perceptions of the destination. Tourist behavior and brand building and promotional strategies were analyzed. Their impact on sustainability in the context of ecotourism and tourism management was pointed out.

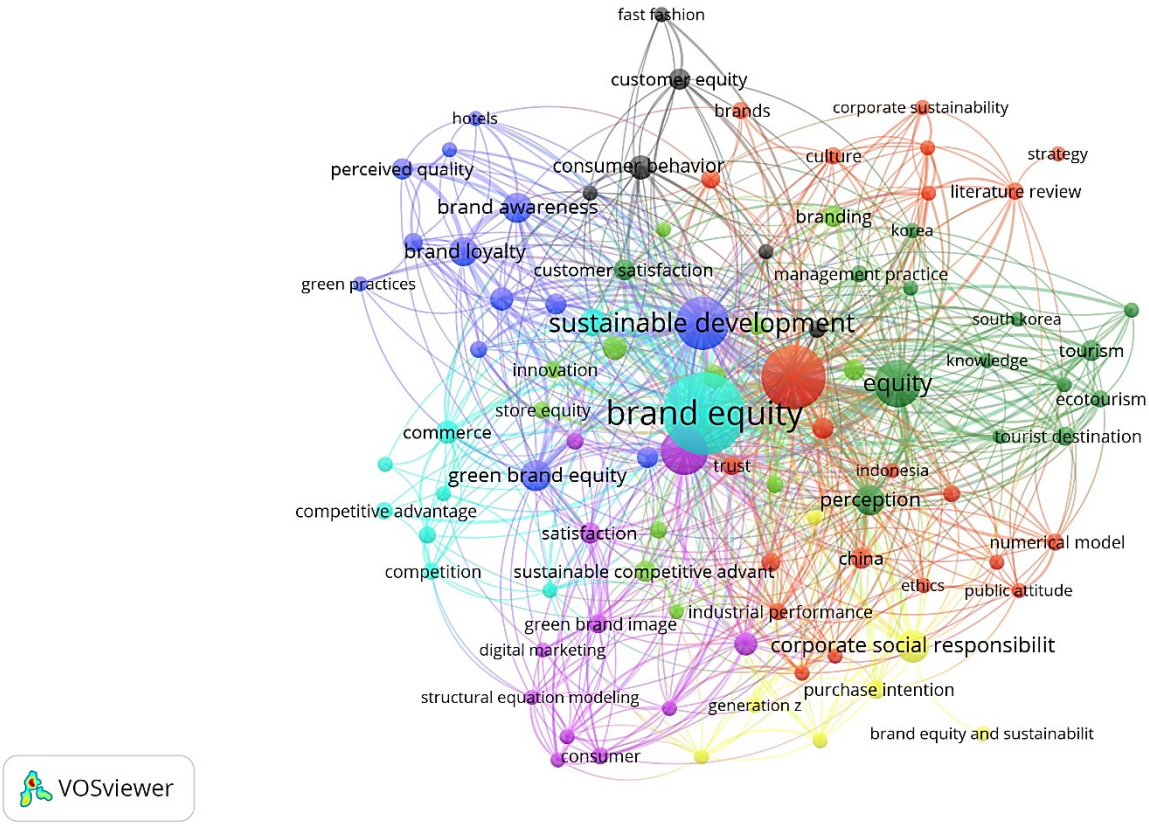

Figure 4. Clusters of keyword co-occurrence using bibliometric mapping of SuBE publications.
Source: VOSviewer based on Scopus data, as of 31.12.2024.

Cluster No. 3 (in dark blue) can be titled as *Sustainability and green economics.* It covers 20 keywords, including *business development, environmental economics, ethics, financial system, green brand equity, green brand image, green purchase intention, green satisfaction, green trust, industrial performance, stakeholder, strategic approach, sustainability, sustainability marketing,* and *trust.* Topics include green brands and sustainability, with special attention given to green purchase intention and green trust. The key role of stakeholders in implementing sustainability practices and creating transparent green communication strategies was pointed out. The role of business ethics, environmental economics, and financial systems in promoting more sustainable business models was also analyzed.

Cluster No. 4 (in light green) titled *Consumer behavior and social media* covers 15 keywords, including *awareness, brand equity and sustainability, brand value, consumer, corporate social responsibility, digital marketing, generation z, human, purchase intention, satisfaction, social media, sustainable consumption,* and *willingness to pay.* The topics of the publications classified in this cluster based on the keyword co-occurrence concern the impact of social media on consumers' purchasing decisions and relationships with brands. Brand awareness and purchase intention proved relevant to analyzing consumer engagement in the digital space. Issues related to digital marketing, influencers of sustainable consumption, corporate social responsibility, social media, and brand value were also studied.

Cluster No. 5 (in violet) titled *Communication and consumer decisions* covers 12 keywords, including, for example, *business, communication, consumer-based brand equity, decision making, perception,* and *price premium.* The publication's topics relate to decision-making processes with aspects such as value perception, willingness to pay a premium price, and consumer satisfaction and loyalty. Product features that influence purchasing decisions were also analyzed.

Cluster No. 6 (in light blue) can be described as *Corporate strategies and consumer behavior.* It contains 11 keywords, for example, *brand management, brands, consumer behavior, corporate strategy, corporate sustainability, culture, strategy, sufficiency economy,* and *value co-creation*. Topics in the publication point to corporate strategies, relating to corporate sustainability and value co-creation, and their impact on consumer perceptions of brands. It also examines consumer behavior in different cultural contexts, with a focus on building relationships with consumers in marketing strategies implemented by global corporations.

Cluster No. 7 (in yellow) can be titled as *Consumer behavior and innovation in circular economy.* It contains 9 keywords, including *advertising, circular economy, consumer behavior, consumption behavior, customer equity,* and *fast fashion.* The publications analyzed consumer behavior in the context of the circular economy. Attention was paid to innovative business models that can promote sustainable consumption. Fast fashion was studied from the point of view of possibilities to reduce its negative impact on the environment. In addition, effective integration of sustainable practices was pointed out.

Cluster No. 8 (in brown) can be described as *Loyalty and sustainability in the hotel industry.* It contains 8 keywords, including *brand awareness, brand loyalty, environmental sustainability, hotels, perceived quality, social sustainability, sustainable development* and *sustainable practices.* Sustainable development strategies in the hotel industry were studied for increasing customer loyalty and improving brand image. In addition, service quality, sustainable practices, and customer perceptions of hotel brands were analyzed.

Cluster No. 9 (in pink) identified as *Modern research methods in marketing* contains 7 keywords, including *brand credibility, covid-19, questionnaire survey, scale development, service quality,* and *social media marketing.* The publications analyze advanced research

techniques for a more thorough understanding of marketing trends. Determinants of service quality and brand credibility were studied in the context of the effectiveness of marketing efforts, including social media marketing.

Cluster No. 10 (in black), titled *City brands and their value,* includes the single keyword *city brand equity.* The topic focuses on city brand equity and its role in attracting tourists. Important in this context is improving the competitiveness of cities in the context of the effectiveness of promotional campaigns.

5. Discussion of results and implications

The purpose of this study was to identify the state of research in the field of SuBE using bibliometric analysis with special attention given to thematic areas. The current level of knowledge on the subject of SuBE, the identification of known authors, countries, and sources, as well as the identification of thematic areas that are significant for SuBE, were all included in the three research questions.

The first question was assessing the level of development of the SuBE field of study. By the end of 2024, 340 publications on SuBE had been published, with an average value of 12.1 publications per year. The largest number of publications was published in the 2021-2024 period; there were 170. In comparison, 150 studies were published in the 2011-2020 period. The difference can be seen in the average number of publications; in the 2011-2020 period, an average of 15 studies per year were published, while in the 2021-2024 period, this average value was 42.5 studies per year. The importance of this area is also evidenced by the number of citations. In total, publications indexed in the Scopus database were cited 5,671 times. This means an average number of citations of 202.5 per year. The highest number of citations was recorded in the 2021-2024 period; there were 3,848 citations. In comparison, in the 2011-2020 period, the number of citations of publications related to SuBE was 1,749. The comparison of the average annual number of citations shows an increase in the importance of the subject. In the 2011-2020 period, the number of citations was 174.9 per year, while in the 2021-2024 period, this number increased to 962 citations per year.

The second research question focused on identifying authors and countries relevant to the SuBE research area. The authors of the largest number of publications were Gil-Saura I., Ruiz-Molina M.E., and Marín-García A., who published 12, 9, and 7 studies, respectively. The United States turned out to be the most affiliated country, followed by India, China, the United Kingdom, and South Korea. These five countries accounted for 50% of all publications on SuBE indexed in the Scopus database. The bibliographic coupling identified 68 countries. However, considering the minimum number of documents at level 3, 8 clusters

were identified. South Korea and India belonged to the first cluster, the United Kingdom and the United States to cluster No. 3, while China was in the sixth cluster.

Answering the third question, analysis of the keyword co-occurrence using mapping analysis allowed the selection of 10 clusters. According to the cluster research, globalization and regional socioeconomic changes present both opportunities and problems for modern brand management, marketing, and communication strategies. An interdisciplinary and dynamic research and practice environment was created by combining issues like consumer behavior, circular economics, sustainable development, branding and competitiveness building, brand management in the context of tourism services, and contemporary marketing research methods (Buckley et al., 2022; Hassan et al., 2023; Kim et al., 2015).

One crucial area of marketing and management is brand development and competitiveness in relation to sustainable development (Javed et al., 2024; Tung, Vigneron, 2023). Brands must set themselves apart in the face of intense global competition and shifting consumer expectations by being able to connect emotionally with their target audiences in addition to offering high-quality goods and services. In the tourism services industry, where customer experience, authenticity, and a region's or city's image are crucial in fostering enduring loyalty, brand management is especially crucial (Bordian et al., 2024; Chan, 2019).

The circular economy and sustainability are significant components of modern marketing plans. Brands must incorporate social and environmental responsibility into their operations due to the increasing environmental consciousness of societies and global environmental responsibilities. The circular economy, which is founded on the ideas of reducing waste and optimizing resource value, is evolving into both a goal and a chance to develop creative business solutions. Customers expect firms to be open, accountable, and dedicated to eco-friendly practices as they become more conscious of their influence on the environment (Kumar et al., 2022; Matteucci, 2020). A crucial part of this process is communication, which affects customer choices. Since today's consumer is both highly demanding and knowledgeable, effective communication needs to be real-time, authentic, and individualized. Social media has grown to be a significant platform for brand-consumer communication, providing fresh chances to engage audiences, examine behavior, and form connections. Online reviews, suggestions, and opinions frequently influence consumer choices, making reputation management and user-generated content marketing even more crucial (Duh, Uzezi Wara, 2024; Qi et al., 2024).

Additionally, marketing innovations are embracing customer loyalty, particularly in the hotel sector, where a significant difference is the combination of outstanding service and sustainable practices. Consumers are more inclined to select companies that provide contemporary, tailored solutions while exhibiting respect for the environment and local communities. A deeper comprehension of consumer behavior and the efficacy of marketing initiatives is made possible by modern marketing research methodologies. Using social media data, artificial intelligence, and advanced analytics enables the development of tailored tactics in addition to trend forecasting (Golob et al., 2020; Kumar, Bagchi, 2020; Wang et al., 2014).

In summary, the previously mentioned concerns highlight the increasing significance of a multidisciplinary approach in marketing that incorporates consumer behavior analysis, cutting-edge technologies, communication methods, and sustainability. To succeed in a world that is changing quickly, today's brands and organizations must exhibit not only innovation but also social and environmental responsibility.

Based on the bibliometric analysis, theoretical and practical implications for sustainable brand equity can be formulated. The theoretical implications include the need to integrate theories from marketing, management, sustainability and communications to understand how brands can simultaneously meet consumer expectations and achieve environmental goals. This will make it possible to present fresh theoretical frameworks that consider how circular economics affects brand equity, brand value, and brand loyalty. The approach to consumer behavior needs to change, and studies on consumer choices need to consider how social media is becoming a more significant influence on sustainable preferences. When creating analytical models, it is important to consider how sustainability, loyalty, and consumers' perceptions of brand value interact. From the perspective of the development of tools and methodologies using artificial intelligence, big data, and real-time analytics for the analysis of changing consumer sustainable behavior, it is also vital to highlight contemporary research methods in marketing.

Practical implications should be pointed out that companies must include sustainability as a central element of their branding strategy to build lasting relationships with environmentally conscious consumers. To attract clients who are searching for unique and ethical experiences, travel agencies might highlight authenticity and locality in their activities. Additionally, organizations should use social media to assess customer behavior and instantly determine their needs in addition to using it for communication.

To promote sustainability, companies can introduce loyalty programs that promote consumers' green choices, such as discounts for repeated use of goods and services with a low carbon footprint. Implementing circular economy practices in business processes can not only reduce operating costs but also increase consumer involvement in green activities. Additionally, companies should employ sophisticated data analytics in conjunction with contemporary research methods to forecast market trends and make real-time strategy adjustments. In this sense, the creation of digital platforms and mobile applications can aid in the study of customer behavior and make it easier to use creative marketing strategies.

6. Conclusions, limitations, and future research

SuBE is an important issue in the context of management, marketing, and sustainability. It is related to the importance of sustainability in marketing strategies. In this context, sustainability is becoming a key factor in determining the competitiveness of brands.

At the same time, the role of social media and technology is growing dynamically. Social media has significantly influenced the way consumers interact with brands. In turn, new technologies enable precise analysis of their behavior and preferences. Shaping SuBE considered in the context of brand management requires the integration of knowledge from various fields, such as marketing, economics, technology, and social sciences.

This study also has limitations. First, there is the diversity of regional and cultural contexts. The influence of culture, local economic conditions, and the level of environmental awareness can vary from region to region. This issue was not analysed. Second, time frames were not analysed. The dynamics of technological change, evolving consumer behavior, or approaches to sustainability can affect the issues analysed in the context of SuBE.

Several issues should be identified as directions for future research. First, the long-term impact of sustainability strategies should be studied. Research should focus on analysing how brands' pro-environmental and pro-social activities affect their long-term consumer loyalty and market value. Second, loyalty in the context of the circular economy would be an interesting research area. Currently, there is a lack of extensive research indicating how circular strategies affect consumers' brand perceptions and purchase decisions. Third, research analysing the post-pandemic reality should continue. In-depth studies of changes in consumer behavior and brand adaptation in response to the effects of the COVID-19 pandemic in the context of sustainability and digitalization would be important.

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RESEARCH ON KEY REQUIREMENTS FOR THE POSITION OF JUNIOR PROJECT MANAGER

Joanna IWKO[1], Barbara KUBEK[2*], Jakub PIWIŃSKI[3]

[1] Faculty of Management, Wroclaw University of Science and Technology; joanna.iwko@pwr.edu.pl, ORCID: 000-0002-7802-8412
[2] Faculty of Management, Wroclaw University of Science and Technology; 266657@student.pwr.edu.pl, ORCID: 0009-0002-5136-0471
[3] Faculty of Management, Wroclaw University of Science and Technology; 266651@student.pwr.edu.pl, ORCID: 0009-0000-2413-946
* Correspondence author

Purpose: The aim of this study is to identify and analyze the key requirements for candidates for the position of Junior Project Manager in job offers on recruitment portals.
Design/methodology/approach: The study used a literature review and quantitative research using a survey questionnaire. The analysis was conducted on the basis of 70 job offers available on recruitment portals.
Findings: The results of research and analyzes of job offers indicate the growing importance of soft skills, such as communication and independence, as well as 2-5 years of experience in project management. Employers prefer candidates who combine theoretical and practical knowledge.
Research limitations/implications: The limitation of the research concerns in particular the location of job advertisements for the position of Junior Project Managers. Most offers concern recruitment to companies located in Wrocław. The concept of Junior Project Manager is very rarely found in the literature. Our research therefore partially fills this gap.
Practical implications: The study results could be used by project-oriented companies to improve their recruitment processes and by universities to modify their curricula in order to adapt them to the current requirements of the labor market.
Social implications: What will be the impact on society of this research? How will it influence public attitudes? How will it influence (corporate) social responsibility or environmental issues? How could it inform public or industry policy? How might it affect quality of life? Not all papers will have social implications.
Originality/value: The novelty of the article is that it discusses an issue that rarely appears in the literature on the subject, i.e. the requirements set for recruitment for the position of Junior Project Manager. The research results can be addressed to recruiters and people responsible for shaping study programs at universities.
Keywords: Junior Project Manager, competences, requirements, recruitment.
Category of the paper: Research paper.

1. Introduction

Project management is one of the key tools of modern organisations to achieve their strategic objectives in a dynamically changing economic environment. It is the process of planning, organising, controlling and closing project work in order to achieve specific objectives within a set time and budget constraint. The importance of projects in the modern world is steadily increasing and this is an ongoing trend. This is due to a number of circumstances, notably the increasing complexity and variety of problems and projects required to solve them (Trocki, 2012).

The choice of topic for this study was prompted by the growing demand for project management professionals, including junior project managers (Junior Project Managers). As more organisations adopt project-based approaches, recruiters are looking for talent that combines theoretical knowledge with practical skills, as well as the ability to work in multi-disciplinary teams (Crawford, 2005).

The purpose of this study is to identify and analyse the key requirements placed on candidates for the position of Junior Project Manager in job offers on recruitment portals. The study focuses on two main aspects: the identification of the most common mandatory requirements, such as work experience or knowledge of project management tools, and the analysis of non-standard requirements that may set candidates apart from the competition.

The study used a literature review and quantitative research using a survey questionnaire. The analysis was based on job vacancies available on recruitment portals. The study provides practical guidance for young candidates as well as for organisations responsible for recruitment processes and universities training in project management.

2. Literature analysis

Both academic literature and practical project management standards point to the vital importance of project managers' competencies in achieving an organisation's objectives. The Project Management Institute, in its PMBOK guide, defines the role of the project manager as the person responsible for managing the project team to achieve project objectives and meet stakeholder expectations (Project Management Institute, 2017). The IPMA ICB standard, on the other hand, emphasises the development of individual competence in project management (International Project Management Association, 2015).

As the demand for project managers grows, so does the interest in their competencies and in standards for competence development and assessment (Crawford, 2005). A project manager, in order to carry out his or her tasks effectively and efficiently, must possess the right

competencies, which can be defined as dispositions in knowledge, attitudes and skills that enable professional tasks to be carried out at an appropriate level (Filipowicz, 2019). A number of studies have been conducted on the competencies of project managers. They show that the most important competencies of a project manager are behavioural (human) competencies. These include interpersonal communication, teamwork, entrepreneurship and creativity, self-reflection and self-management, professionalism and ethics, result orientation, leadership, negotiation, conflict management, among others (Marek-Kołodziej, 2024). Another study also indicates that interpersonal skills as the most important area of a leader's competency, such as: communication skills, inspiration, motivation, building trust, and cooperation (Balcerzyk, Žukovskis, 2024). For Junior Project Managers, on the other hand, it is particularly important to combine technical and interpersonal skills to enable effective collaboration in multidisciplinary and multicultural teams (Borg et al., 2023). The findings show that through initiatives aimed at increasing self-efficacy, organisations can support the development of junior project managers, improving their work readiness and potential for further development (Borg et al., 2023). At the same time, the findings of junior project managers can provide a basis for integrating project management issues into university curricula (Nijhuis et al., 2024).

Understanding the requirements for Junior Project Managers is an essential part of an effective recruitment process. These expectations include knowledge of project management tools such as MS Project or Jira, time management skills, as well as interpersonal competencies such as communication and teamwork. In addition, organisations often expect candidates to be adaptable and to work under time pressure.

In the light of the theoretical issues presented, the following section of the study will present the results of an analysis of job offers for the position of Junior Project Manager posted on recruitment portals, showing the detailed requirements for candidates at this career stage.

3. Research process

The research presented in this article was conducted by a team of five people who are members of the Project Management Group Scientific Association at the Faculty of Management, Wrocław University of Science and Technology. The aim of the research was to identify and analyse the requirements for candidates for the position of Junior Project Manager on the labour market, including what competencies, work experience and personality traits considered key.

The survey consisted of four stages:

1. Stage I - creation of a tool to collect data.
2. Stage II - data collection.
3. Stage III - data selection.
4. Stage IV - analysis of results.

A detailed description of the different stages of the study is presented later in the paper.

3.1. Creation of a tool to collect data

In Stage I, an analytical questionnaire developed using GoogleForms, which allowed information to be collected from job vacancies for the position of Junior Project Manager posted on recruitment portals. The form was designed to allow the research group to enter all details of the mandatory requirements, type of contract, full-time hours and required competencies. Sections of the form included:

- Job publication site (e.g. recruitment portals, company websites).
- Mandatory requirements (language, technical, soft, project management).
- Type of contract and full-time hours.
- Experience required.

3.2. Data collection

The data presented in this article was sourced from the most popular Polish recruitment platforms, which play a key role in the recruitment and candidate selection process, as well as the 'Careers' section from the websites of companies based in Wrocław. The offers came from various industries, including IT, finance, marketing and business services. The study analysed 70 job offers published on eight platforms, which provided a cross-sectional view of the requirements for candidates for the position of Junior Project Manager (Stage II). Figure 1 shows the job offers collected for analysis by the individual online portals from which they originated:

- Indeed (4.29%): A global platform known for its versatility and broad job database. The low participation in the survey may be due to the lower number of offers dedicated to specialised positions in project management (https://pl.indeed.com/).
- Other (1.16%): A tiny percentage of offers came from less popular platforms, indicating their limited role in recruitment for the positions analysed.
- BulldogJob (7.14%): A platform aimed mainly at the IT industry, which may suggest a greater specialisation and interest in project-related positions in information technology (https://bulldogjob.pl/).
- RocketJob (20%): The largest share in the survey. This platform, despite its relatively short time on the market, has clearly gained recognition among recruiters, which may indicate its effectiveness in reaching young professionals (https://rocketjobs.pl/).

- the:protocol (10%): A platform related to the IT industry, which played an important role in the analysis, highlighting the importance of this industry for young project managers (https://theprotocol.it/).
- JustJoinIt (11.43%): A popular Polish platform, particularly appreciated in the technology sector, which attracts candidates to work in dynamic environments (https://justjoin.it/).
- Pracuj.pl (15.71%): One of the largest recruitment platforms in Poland, widely used in recruiting for positions of various levels (https://www.pracuj.pl/).
- LinkedIn (12.86%): An international professional platform with a wide reach that connects candidates with job opportunities in various industries. The high number of listings demonstrates its importance in professional networking and recruitment processes (https://www.linkedin.com/).
- No Fluff Jobs (17.41%): A platform specialising in transparent IT adverts that attracts candidates who value clear terms of employment (https://nofluffjobs.com/pl).

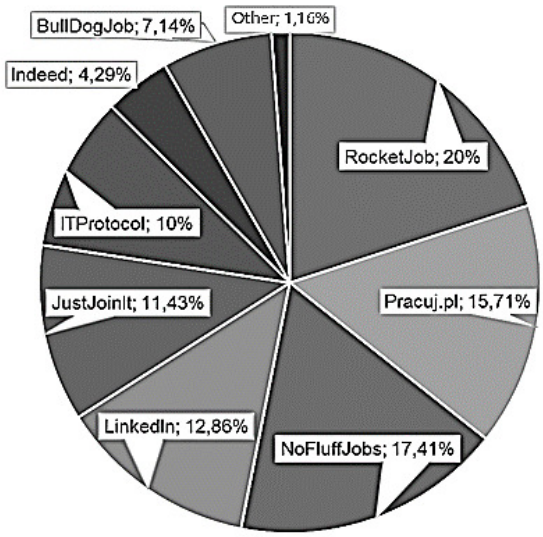

Figure 1. Job vacancies on recruitment portals (%).
Source: own elaboration based on survey.

3.3. Data selection

As part of Stage III, the Team analysed the adverts based on predetermined criteria relating to the job title, location provided and other elements included in the form used to collect them. Only those advertisements that were for Junior Project Manager positions or similar project management roles were considered. In each case, information on the required competencies, work experience, language skills and additional qualifications required by the employers was noted in detail.

3.4. Analysis of results

In Stage IV, the collected data was organised and subjected to detailed analysis. Data visualisation and business analysis tools were used, such as the programme *Tableau*, which allowed the results to be visualised and the number of job vacancies in each industry and the required competencies to be presented graphically. The charts enabled a comparative analysis and a complete picture of the requirements for candidates for the Junior Project Manager position.

4. Results

Based on the analysis, a number of key requirements that dominate job offers for Junior Project Managers have been identified and are shown in Figures 3-5.

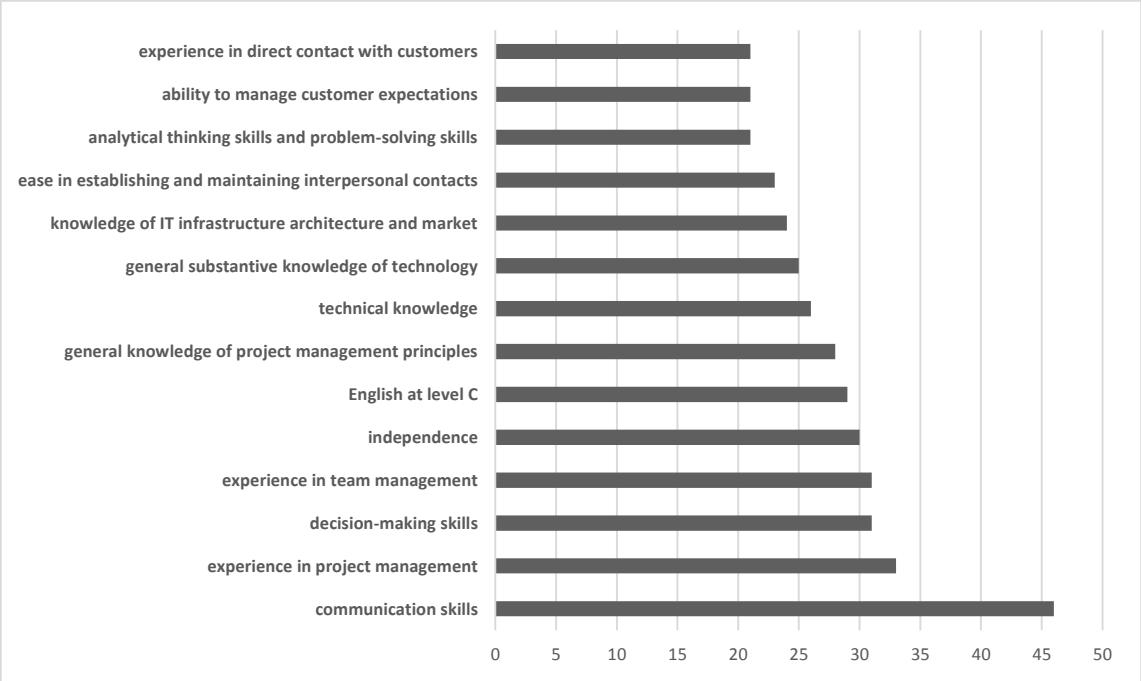

Figure 3. Requirements for the position of Junior Project Manager (1).

Source: own elaboration based on survey.

The most common requirement was the ability to communicate, present in 46 offers, indicating the crucial importance of soft skills in project management. These requirements can range from the ability to communicate effectively with team members to external stakeholders, which is essential for effective project management.

A number of offers (in the range of more than 20 offers) also included the need for work experience related to project management (this was specified in 33 offers) and experience related to team management (this requirement was specified 31 offers). This may indicate

a trend where candidates are expected to have leadership competencies early in their management career, which may be challenging in the context of a Junior Project Manager position.

Autonomy, which was required in 31 offers, also appears as one of the key requirements. Autonomy is difficult to define and its interpretation can vary from organisation to organisation.

A significant number of offers (29 offers) also included a requirement for English language skills at level C. In the context of globalisation and international cooperation, a good knowledge of English is becoming standard in many industries. Surprisingly few offers required knowledge of other foreign languages, such as German or French.

An interesting observation is the increasing importance of technical knowledge in the job of Junior Project Manager. This requirement appeared in 26 offers, as well as knowledge of the IT infrastructure market (24 offers) and systems architecture. This indicates the growing role of technology in project management, especially in IT industries.

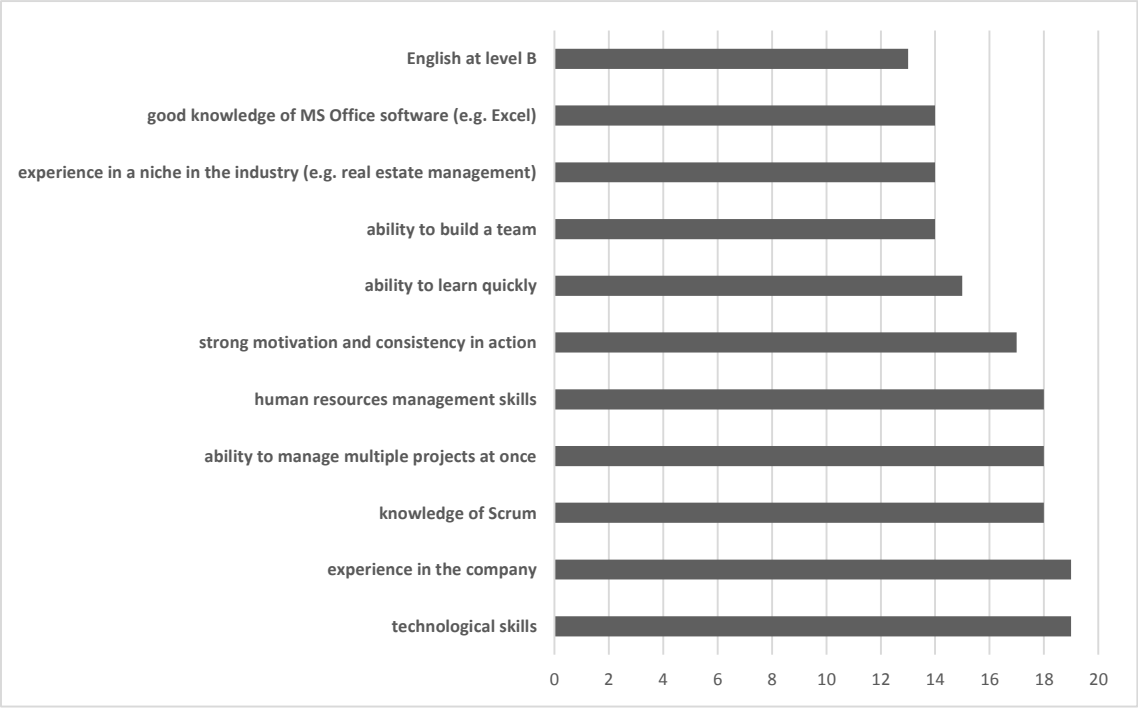

Figure 4. Requirements for the position of Junior Project Manager (2).

Source: own elaboration based on survey.

Mandatory requirements that occurred between 10 and 20 of the job offers analysed include technological skills, team-building skills, good knowledge of MS Office software. Additionally, knowledge of agile methodologies (18 offers) and general project management principles (28 offers) indicate the popularity of Agile methodologies, which have become a standard in the IT industry. An interesting aspect is the lack of certification requirements, which suggests that recruiters value practical skills more than formal proof of competence.

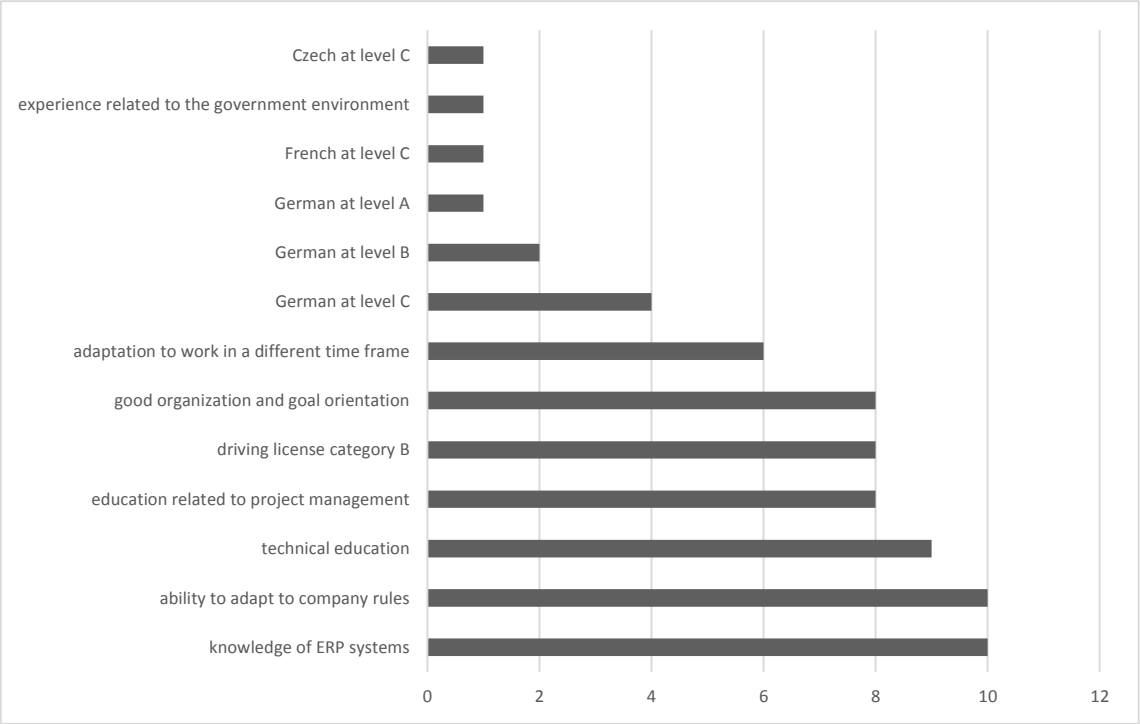

Figure 5. Requirements for the position of Junior Project Manager (3).

Source: own elaboration based on survey.

Among the mandatory requirements that occasionally (in a maximum of 10 offers) occurred in the job offers analysed, we can point out: education (completed Bachelor's or Engineer's degree) related to project management, technical education, or knowledge of foreign languages other than English.

The **work experience results,** shown in Figure 5, provide important information about the experience requirements of recruiters for the position of Junior Project Manager. The figure shows five categories that range in experience from no requirements at all to candidates with more than five years of experience in the field.

The analysis of the results shows that recruiters are most often looking for candidates with work experience in the range of 2 to 5 years, with many offers also lacking exact experience expectations.

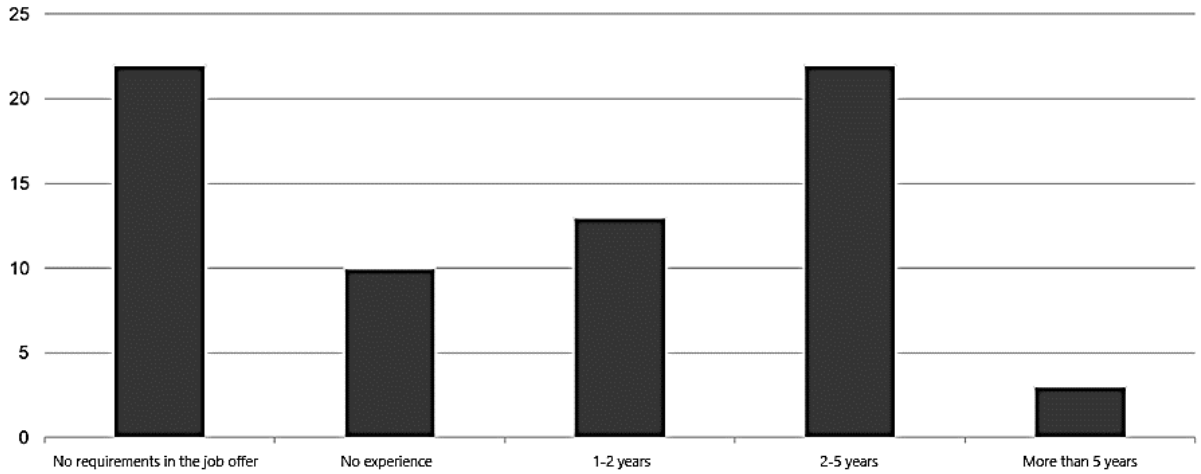

Figure 6. Required work experience for the position of Junior Project Manager (pcs).
Source: own elaboration based on survey.

A significant number of offers either did not include a requirement for work experience or required 2-5 years of experience. This means that for many employers, project management experience was not an important selection criterion or they expected candidates to have intermediate level experience of between 2 and 5 years. This distribution may suggest that the Junior Project Manager position is seen as a role that already requires some experience, but not necessarily a long one. Employers who are looking for candidates with experience in the 2 to 5 year range often prefer individuals who can implement new tasks quickly, but do not yet expect the high level of autonomy and responsibility typical of more experienced managers.

'No experience', on the other hand, appeared in the lowest number of adverts, suggesting that recruiters rarely choose to hire candidates with no prior project management experience. Although the Junior Project Manager position implies an entry-level role, organisations typically expect a certain experience base that will enable a young employee to adapt more quickly to the challenges of running projects. Such a requirement may be related to the fact that, in a management position, it is not just theoretical knowledge that counts, but also the ability to apply it in practice in the context of projects.

The ‘Over 5 years experience' bracket also occurred in a small number of advertisements surveyed, indicating that employers are rarely looking for candidates with this much experience for a Junior Project Manager position. This may suggest that they are looking more for people who have project management experience, but not necessarily full-time experience, allowing them to develop further within the organisation. From the information provided, it can be inferred that organisations are reluctant to hire people with more experience as they may expect higher salaries or find it difficult to accept a lower role within the organisation. Hiring individuals with more than five years' experience may also be associated with less flexibility to adapt to the working methods characteristic of organisations seeking younger employees.

From the analysis of the results regarding the work experience requirement, the following conclusion can be drawn: there is a prevailing trend on the labour market where employers prefer to hire people with project management experience in the range of 2 to 5 years. These types of candidates already have the basic skills and knowledge, but are still able to adapt quickly to the specifics of an organisation that can offer further career development in project management. By contrast, offers are rare for those with no work experience or very extensive experience. Such figures suggest that the Junior Project Manager position is seen as a role that requires some experience, but candidates are not expected to have a high level of autonomy and responsibility.

Another important aspect that was considered in the analysis of job offers for the position of Junior Project Manager is **the scope of work and the full-time hours** that appear in the advertisements (Figure 7). The results of the survey indicate that the vast majority of the offers (92%) provide for full-time employment, which means that employees hired for this position will in most cases work a standard number of hours per week, most often 40 hours. This type of employment is the most common option chosen by employers and is one of the primary expectations in offers for the Junior Project Manager position.

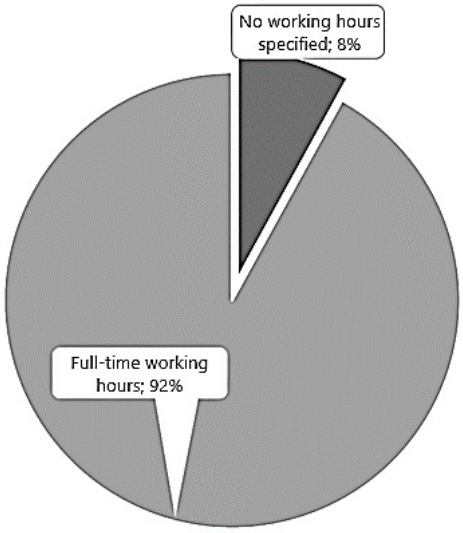

Figure 7. Required hourly working hours for the Junior Project Manager position (%).

Source: own elaboration based on survey.

Full-time hourly work in this context can be considered the industry standard, especially in large organisations where designing, coordinating and monitoring the progress of projects requires systematicity and the full commitment of the employee. Full-time employment also provides the opportunity to be fully integrated into the team, to participate in daily project meetings and to collaborate with other departments of the organisation on an ongoing basis, which is particularly important in the case of the Junior Project Manager position. Employers, when deciding on this working time, usually expect candidates to be fully available, which fosters effective project management and enables young professionals to develop quickly by engaging in a variety of tasks on a daily basis.

Despite the predominance of full-time employment, positions with indefinite working hours appeared in around 8% of the offers analysed. This may mean that employers are offering greater flexibility in working hours, which is particularly attractive in the context of a dynamic labour market, the growing importance of work-life balance and well-being (Procházka, Bočková, 2024). In such offers, employers may suggest the possibility of part-time work or offer flexible working hours, allowing the employee to adjust their schedule to accommodate other commitments or personal preferences. These types of options may be particularly attractive to those who are studying, working on different projects at the same time or seeking a better work-life balance.

Flexible working hours may also result from the organisational policies of companies that place trust in their employees and allow them to manage their own working time. On the other hand, the offer of a job with non-standard working hours may also refer to employment contracts that do not require a full commitment to a standard working mode, but allow tasks to be completed on a flexible basis. In this case, employers may expect Junior Project Managers to work on a project in a more structured way, based on flexibility of working hours, which may involve less stress and more autonomy in organising their own working time.

This type of offer, although a minority, can be attractive in the context of new trends in the labour market, such as remote working, hybrid working and offering non-standard working hours. Flexibility in terms of working hours can attract people who value the ability to tailor working hours to their individual needs, while also enabling companies to attract younger workers who are more willing to be flexible.

5. Conclusions

The study presented in this paper aimed to identify and analyse the key requirements for candidates for the position of Junior Project Manager. The analysis was based on 70 offers from various recruitment platforms, providing a picture of recruiters' expectations of young project management professionals. The study focused on the identification of the most common requirements in terms of work experience, technical and soft skills, as well as an analysis of the scope of work, including full-time equivalents.

In terms of technical competence, offers most often required knowledge of project management tools and technical knowledge related to IT systems architecture and IT infrastructure markets, which may reflect the growing influence of technology on project management processes. In addition, emerging requirements for knowledge of agile methodologies (including SCRUM) reflect the current trend in the IT industry, where flexibility in project management methodologies is key. Another interesting finding of the survey is the

lack of explicit requirements for certification in the area of project management, which may suggest that practical experience is valued more than formal proof of skills.

In terms of working hours, the survey found that the predominant form of employment is full-time, accounting for 92% of the offers analysed. This type of offer ensures employees are fully integrated into the project team and have a permanent presence in the organisation, which is important in the context of delivering projects that require ongoing coordination and commitment. Only 8% of offers provide for flexible working hours or non-standard full-time hours, which may indicate the growing role of flexibility in the workplace, especially in the context of the changing expectations of today's employees, who are looking for more autonomy in organising their working time.

In the context of the work experience analysis, the survey results reveal a dominance of the 2-5 years of experience category, indicating that recruiters prefer candidates who have some project management experience, but at the same time do not require excessive experience that could limit the flexibility of hired employees. The least sought after were those with no work experience and those with more than 5 years' experience, which may indicate a preference for people who can quickly get into complex project processes but do not yet expect a high level of responsibility.

The conclusions of the survey indicate the increasing importance of soft competencies such as communication and self-management, which are key in the work of a project manager, especially in the position of Junior Project Manager. The results of another study of project manager competencies also show that certain competencies are highly sought after in the job market. These include competencies from the 'Practice' category (Plan and Control, Stakeholder, Organisation and Information, Requirements and Objectives, Scope and Time) and 'People' category (Personal Communication, Relationships and Engagement, Teamwork, Leadership) (Zemlińska-Sikora, Kozarkiewicz, 2023). Furthermore, the results of the research show that companies are looking for candidates for the position of Junior Project Manager with project management experience in the range of 2-5 years, which indicates the need to hire employees who have adequate theoretical and practical knowledge, but are also still open to learning and adapting in a new environment. Employers rarely choose to hire people with no experience, highlighting the importance of at least a minimum background in project management.

Further research could analyse the impact of specific educational programmes on the level of preparation of candidates for work as project managers. In addition, it would be worthwhile to explore differences in employers' expectations depending on industry or geographical location. The research could also serve as a prelude to a broader analysis of the role of universities in shaping practical skills and their cooperation with the labour market.

The results of the research may be relevant both for universities, which could better adapt their educational programmes to the needs of the labour market, and for students, who would thus be better prepared to meet the requirements of employers. For recruiters, the research could

provide guidance for an optimal candidate selection process, as well as raising awareness of the importance of soft skills. As a result, they can contribute to an overall improvement in the quality of project management in organisations.

Finally, it is worth mentioning that project-oriented organisations should support Junior Project Manager recruits through, among other things, mentoring, training, collaboration with universities, providing feedback and assigning manageable tasks (Borg, Scott-Young, 2022).

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METRICS FOR MEASURING THE ACHIEVEMENT LIKELIHOOD OF VALUES IN UNIVERSITY R&D PROJECTS

Joanna IWKO[1], Dorota KUCHTA[2*], Oksana BEZGIN[3]

[1] Faculty of Management, Wroclaw University of Science and Technology; Joanna.iwko@pwr.edu.pl, ORCID: 000-0002-7802-8412
[2] Faculty of Management, Wroclaw University of Science and Technology; dorota.kuchta@pwr.edu.pl, ORCID: 0000-0002-9747-0759
[3] Faculty of Management, Wroclaw University of Science and Technology; oksana.bezgin@pwr.edu.pl
* Correspondence author

Purpose: The purpose of this paper is to investigate the potential for using metrics to measure the likelihood of achieving the values desired by project stakeholders of R&D projects in the university context and to propose a selection of metrics for practical application.
Design/methodology/approach: A literature review was conducted to identify the metrics proposed for R&D projects and the values expected from such projects by stakeholders. Interviews with R&D project managers from universities were carried out to determine the current use of metrics in university-based R&D projects. Conceptual analysis was employed to propose a selection of metrics to be introduced, on an obligatory basis, into the management of R&D projects at universities.
Findings: A very low maturity in value-based and metrics-based project management at universities was confirmed. While several metrics are used, they are not those related to project values, which is detrimental to the success rate of R&D projects at universities. The use of value-based metrics should be gradually embedded in the management of R&D projects at universities.
Research limitations/implications: The findings described in the paper require case studies of practical application, through which the list of values and the corresponding metrics can be completed.
Originality/value: The problem of the absence of value-based and metrics-based project management in the university context was emphasized, and an initial proposal was formulated regarding how these aspects should be implemented at universities. The targeted audience of this paper includes individuals involved in the management of R&D projects at universities, whether as project managers, project team members, university division managers, or employees of project funding institutions.
Keywords: project success, project value, R&D project, project metric.
Category of the paper: research paper.

1. Introduction

R&D projects at universities consume significant amounts of money and effort. Unfortunately, they are not always successful. For instance, according to one research study, Exploratory Research Projects had a success rate of 24.2%, Postdoctoral Research Projects averaged 43.4%, and Research Projects for stimulating young independent teams had a success rate of 18.5% (Rusu, Mocanu, Bibiri, 2022).

Two aspects are increasingly recognised as important in project management, including in the context of R&D projects: value-based management (The Knowledge Academy, 2024), and metrics-based management (Kerzner, 2013). A project cannot be considered successful if the values desired by its stakeholders are not achieved. Additionally, it is possible, at least to some extent, to measure the likelihood of attaining these values during project implementation, through carefully selected metrics. However, these concepts have been scarcely developed for R&D projects implemented at universities.

For this reason, the purpose of this paper is to investigate the potential for using metrics to measure the likelihood of achieving the values desired by project stakeholders of R&D projects in the university context and to propose a selection of metrics for practical application.

A literature review was conducted to identify the metrics proposed for R&D projects in the existing literature and the values expected from such projects by stakeholders, particularly in the university context. Furthermore, interviews with R&D project managers from universities were carried out to determine the current use of metrics in R&D projects at universities and their preferences regarding different groups of metrics.

Finally, as the findings indicate a very low maturity in value-based and metrics-based project management at universities, an initial attempt was made to identify metrics that could be prioritised to demonstrate to project managers the feasibility and usefulness of using metrics to measure the likelihood of achieving the values desired by stakeholders in university-based R&D projects.

The structure of the paper is as follows: In Section 2, we present the state of the art from the literature on values and stakeholders in R&D projects at universities. In Section 3, we review the metrics proposed in the literature for R&D projects in the university context. In Section 4, we present the results of an interview-based study on the use of metrics in R&D projects implemented at universities. In Section 5, we propose an initial selection of metrics to be used on an obligatory basis in the management of R&D projects at universities. The paper concludes with some final remarks.

2. Value and stakeholders in R&D projects at the university

The task of project management is to achieve the project's goal, which, in the case of research and development (R&D) projects, takes on an innovative context. Under such conditions, the final value of the project is not fully known, as are the research results that will be achieved. Therefore, determining the fundamental objectives of an R&D project is complicated, and their final form is sometimes unexpected (Elmquist, Le Masson, 2009). The ultimate goal of an R&D project, considering its specifics, is to achieve value, which may manifest as profit, collaboration, or the dissemination of new technology to society.

Traditional approaches to project management, despite their efficiency, may limit learning processes, innovation development, and creativity, thereby negatively impacting the value generated by the project (Kerzner, 2015). For this reason, viewing a project through the lens of value becomes crucial, enabling not only the achievement of objectives but also the creation of new benefits for stakeholders.

Creating value in R&D projects at universities presents a significant challenge associated with identifying and measuring the value generated at various stages of their implementation. A key issue is that the outcomes of R&D projects do not always translate directly or immediately into process improvements or innovation creation. R&D projects are inherently aimed at advancing science and specific disciplines, yet their positive impact on practice often becomes observable only after some time.

Managing the value of R&D projects at universities involves assessing the effectiveness and efficiency of project activities and estimating the significance of the achieved outcomes. The fundamental problem in building value in R&D projects at universities is not the low quality of research but rather the lack of knowledge and skills among researchers in steering the development of their research work (Łukasiewicz, 2007; Klaus-Rosińska, 2019) and insufficient knowledge about managing the value of a given project. Without systematic measurement and identification of value indicators, it is difficult to develop an effective method for analyzing and evaluating the value of a project (Zaskorski, 2012). According to Ellis et al. (2005), in the early stages of project implementation, where problems are often complex, dynamic, and poorly defined, value management is particularly crucial. Project managers and research team members are typically unable to precisely estimate the value generated by the project at the outset, as it is dynamically shaped during implementation. This creates both challenges and opportunities for generating new value.

When seeking criteria for measuring and evaluating value in R&D projects at universities, it is essential to distinguish between value evaluation criteria and value-generating factors (Collins, Baccarini, 2004). Criteria are used to measure the value achieved, while factors facilitate its creation and are an integral part of project management. A key aspect is

understanding who evaluates the project's value and for whom it is created, highlighting that the primary criterion is meeting the needs of all stakeholders (Collins, Baccarini, 2004).

In managing R&D projects, it is important to understand that value is created when it is perceived as valuable by the project's recipients (Lepak et al., 2007). Therefore, conducting an in-depth analysis of stakeholder expectations is crucial, as it allows for precise targeting of actions and enables participants to capture the expected benefits from the project. This approach supports effective project management, focusing on maximizing the value delivered to stakeholders, which, in turn, influences the overall assessment of the R&D project's success.

Stakeholder analysis is an essential element of stakeholder management in projects, allowing managers to understand the stakeholder environment and define appropriate actions for various influence groups. The goal of the analysis is to identify and classify key stakeholders based on established criteria that should be tailored to the project's specifics. This process helps determine stakeholders' involvement, aspirations, and responsibilities, supporting management strategies and the development of further analysis criteria.

Values—or, in other words, benefits—gained from the project by stakeholders have different characteristics: economic and non-economic, material and non-material, social and individual, professional and non-professional, internal and external. These values are variable over time and cannot be unambiguously predicted (Łada, Kozarkiewicz, 2010). A consistent set of project value evaluation criteria can potentially assist R&D project participants in the implementation process, aiming to increase the project's overall value (Yu et al., 2005).

An exhaustive list of stakeholders in a university R&D project was proposed by Eckes-Kondak (2021). Stakeholder identification in R&D projects was based on a synthesis of literature analysis and original observations during the implementation of R&D projects. The identified individuals and groups are those potentially significantly influencing the maximization of value in a university R&D project, and determining their expectations regarding the project may contribute to its successful completion. Based on this, Eckes-Kondak (2021) specifies the following stakeholders in a university R&D project:

- Project manager,
- Project execution team,
- Implementing unit,
- University rector,
- University administration,
- Funding institution,
- Suppliers and service providers,
- Enterprises.

R&D projects primarily generate intangible values, such as psychological and social benefits, which are difficult to estimate and require specialized research methods (Eckes-Kondak, 2021). Although material values are easily measurable, they may be less significant than intangible values, particularly in the context of building experience, professional and social

development, and long-term business relationships. Properly defining project goals and understanding stakeholder expectations can significantly influence its success and effectiveness in creating value.

In this paper, we consider the question of how to measure, during project implementation, whether the values desired by the stakeholders have a chance of being achieved. For this reason, the next section is devoted to metrics, in the context of value-based project management and R&D projects.

3. Metrics proposed in the literature for R&D projects

3.1. Metrics in the context of value-based project management

Kerzner (2013) identifies three approaches to measuring value in projects:

1. An approach based solely on return on investment (ROI),
2. An approach focused exclusively on intangible values,
3. An approach that disregards intangible values entirely (Kerzner, 2013, p. 181).

According to the author, an optimal solution may involve a compromise that combines quantitative methods with qualitative assessments of value.

The timing of value measurement in a project plays a critical role, and the choice between qualitative and quantitative metrics may require flexibility throughout the project's lifecycle. Key issues related to measuring value include the feasibility of defining specific metrics, their usefulness in predicting actual value, and the appropriateness of using particular metrics in the project.

The perception of value metrics in projects can vary depending on the perspective from which they are evaluated. Each stakeholder group may prioritize different aspects of the project, influencing how they interpret values such as time, cost, quality, or risk. Project expectations may shift based on the priorities of a given group, meaning that the same metrics can hold different significance and weight depending on the goals being pursued. Understanding these diverse interpretations is critical for effective project management and communication among stakeholders to ensure harmonious achievement of objectives and overall project success.

Viewing metrics through the lens of stakeholder value highlights the diversity of perspectives and expectations associated with project implementation. Each stakeholder group may interpret the same metrics differently, emphasizing the importance of adopting a flexible approach to project management. Although project metrics may appear identical, they are often understood differently by various stakeholder groups. Recognizing these differences enables better project management by tailoring the approach and communication to meet the specific expectations of each group.

In modern times, intangible values have gained broader significance beyond company reputation or intellectual property. They now include elements such as maximizing the efficiency of the project team. Intangible values encompass aspects such as corporate culture, intellectual capital and its accompanying knowledge management systems, executive and project leadership, employee talents, job satisfaction, trust and credibility, and employees' ability to innovate. While these values may seem more challenging to measure, Kerzner (2022) proposes metrics that enable effective evaluation of intangible values, providing essential insights into the potential benefits of project implementation.

3.2. Metrics in R&D projects

Metrics in research and development (R&D) projects play a crucial role in monitoring and assessing progress. However, they differ significantly from traditional metrics used in other types of projects. In projects such as construction or IT, metrics are typically based on time, cost, and quality of execution. In contrast, R&D projects, where results are often uncertain and difficult to predict, require a different approach. This is primarily due to the nature of these projects, which prioritize creativity, innovation, and the discovery of new solutions, and where final outcomes may not be known until the project is completed (Kerzner, 2015).

R&D projects are often characterized by a high degree of uncertainty regarding both results and progress. Designing effective metrics to measure progress, especially in the context of innovation, is therefore a significant challenge. For example, the introduction of new technologies or the development of intellectual property may occur only in the later stages of a project, making it impossible to establish clear indicators of success early on. As noted by Kerzner (2015), creativity and innovation often emerge only after a project's completion, complicating the evaluation of progress during implementation (Kerzner, 2015; Kuchta et al., 2017; Klaus-Rosińska, 2019).

Furthermore, the success or failure of R&D projects is often difficult to define unequivocally. Even if a project does not deliver the expected results, it may generate intellectual value that leads to future innovations or opens new research paths. In this context, it becomes essential to identify the point at which further funding will no longer yield benefits and to recognize termination as a success in avoiding unnecessary losses. Therefore, R&D projects require flexible metrics that account for these less obvious aspects.

The literature lacks precise metrics dedicated exclusively to R&D projects. Many organizations still use traditional metrics that fail to capture the unique characteristics of these types of projects. For this reason, Yakivets proposes introducing metrics that measure the likelihood of R&D project success based on a subjective definition of success (Yakivets, 2022). This concept involves presenting metrics for identifying the causes of failure in R&D projects, allowing for the prediction of certain problems that could contribute to a project's failure. Such an approach enables better adaptation of metrics to the variable and unpredictable conditions of research projects, which can lead to more effective management.

With the increasing number of R&D projects conducted in collaboration between industry and academia (Perkmann et al., 2011), the need for monitoring and evaluating the outcomes of such initiatives has also grown (Grimaldi, Von Tunzelmann, 2002).

The literature indicates that R&D projects carried out within partnerships between universities and industry are critical for economic growth, knowledge and technology transfer, innovation acceleration, and skill development (Cunningham, Link, 2015; Guimon, 2013). Many research centers are established at universities because they are vital sources of new scientific knowledge and technological advances. Academic research plays a key role in supporting innovation (Mowery, Sampat, 2009; Garcia et al., 2019).

Studies show that defining evaluation metrics to measure effectiveness is one of the most important factors influencing the success of R&D collaborations between academia and industry (Skute et al., 2019; Kulatunga et al., 2011; Perkmann et al., 2011; Philbin, 2008). Performance metrics are effective tools for evaluating and demonstrating the value of research activities and collaborative projects involving researchers and practitioners (Daoud et al., 2017). Previous research has shown that assessing the outcomes of such collaborations and setting clear goals are key challenges in managing academia-industry partnerships (Perkmann et al., 2011). However, further research is needed to better understand the effectiveness of academia-industry alliances, as no structured and widely accepted system of performance metrics for R&D projects currently exists (Piva, Rossi-Lamastra, 2013; Bekkers, Freitas, 2011).

A review of previous studies on defining performance metrics for R&D projects in academia-industry collaborations provides insights into how this issue has been addressed:

- Success factors in R&D project management for both sides of academia-industry partnerships were identified (Barnes et al., 2002), and tools were developed to raise awareness of key issues affecting the success of such partnerships.
- Theoretical frameworks based on clustering concepts were introduced to assess approaches to measuring performance in research departments (Samsonowa et al., 2009).
- Challenges related to assessing the outcomes of university-industry collaborations and setting clear goals for R&D projects were addressed (Perkmann et al., 2011).
- It was emphasized that no structured and widely accepted system of performance indicators for R&D projects exists (Bekkers, Freitas, 2011).
- A performance measurement system for R&D activities conducted by public research centers was developed (Agostino et al., 2012).
- The lack of a widely accepted R&D performance indicator system and the need for further research on the effectiveness of performance indicators in such collaborations were highlighted (Piva, Rossi-Lamastra, 2013).
- A methodology based on logic models was proposed to analyze the impact and improve the future performance of R&D partnerships involving universities, industry, and governments (Daoud et al., 2017).

- The common approach of assigning equal weight to different R&D project performance metrics was criticized, as it may lead to erroneous conclusions. A multi-criteria method known as the "best-worst method" was applied to determine the importance of different R&D performance metrics (Salimi, Rezaei, 2018).
- The perception of academic human capital toward university research performance measurement systems was examined (Martin-Sardesai, Guthrie, 2018).

These studies highlight diverse approaches to evaluating performance in R&D projects, with various methodologies and tools aimed at improving the effectiveness of R&D collaborations. Nevertheless, systematic measurement of R&D projects is necessary to determine the benefits delivered through collaboration and compare them with initial expectations (Grimaldi, Von Tunzelmann, 2002; Perkmann et al., 2011). Additionally, measuring the progress of academia-industry collaborations is vital for refining measurement methods and adapting them to the specifics of R&D projects (Healy et al., 2014; Perkmann et al., 2011).

Building on the performance measurement system suggested by Perkmann, Neely, and Walsh (Perkmann et al., 2011) for evaluating the success of academia-industry partnerships, a quantitative method was developed to assess the success of R&D projects conducted in collaboration between academia and industry. This method uses specific results, such as patents, publications, or licenses (Perkmann et al., 2007; Grimaldi, Von Tunzelmann, 2002; Perkmann et al., 2011), as metrics, along with metrics that measure intangible values, such as social relationships, organizational arrangements, or motivations (Perkmann et al., 2007; Perkmann et al., 2011). The method also includes metrics that allow for assessing R&D project success not only after its completion but also throughout its lifecycle (Grimaldi, Von Tunzelmann, 2002).

In Table 1 we can find proposals of metrics to be used in collaborative university-industry R&D projects. They can be referred to values, although the authors do not mention this explicitly.

Table 1.
Metrics to measure the performance of collaborative university-industry R&D projects

Project phase	Project phase element	Performance metrics
Phase preparatory	Capacities of scientists	Scientific impact (h index of scientists)
		% of researchers involved in joint R&D projects in the past
		% of experienced researchers (not assistants)
	Motivation of researchers	% of research income from industry
	Opportunities for industry colleagues	% of colleagues in the industry team with a postgraduate degree or higher level qualification (postgraduate, masters or doctorate)
		% of collaborators involved in past experience in joint R&D programmes/projects
	Motivation of industry colleagues	Existence of an innovation policy
	Opportunities/challenges	Number of opportunities/challenges
	Applied research	% of project ideas with joint target setting

Cont. table 1.

Implementation phase	Management model	Establishing a common management model
Value delivery phase	Intensity of cooperation	% steering committee meetings (held/planned)
		% of events related to the release of results
		% Workplace meetings
		% Progress meetings
		Meetings of the expert team
	Technology	Number of complete standard patents or other applications
	New knowledge	Number of publications
		Number of joint publications
	Management and organisational quality	% Technical deliverables (reports or prototypes) completed on time
	Implementation of management	Implementation of the governance model
	Human capital	% Industry recruitment of PhD students
		Recruitment of research assistants (graduates) by industrial partners
		Perception of the programme's impact on academic or professional career development
		Qualification structure of associates
		Number of master's and doctoral degrees
Completion phase	Innovation	Number of new products
		Number of new process improvements
	Solution concepts	Number of new solution concepts
	New ideas	Number of new project ideas
Post-completion phase	Technological achievements	Number of patents granted
	Revenue	Revenue growth
	Sustainability of the partnership	Value of new joint research projects generated

Source: (Fernandez et al., 2017).

To summarize the state of the art in the area of metrics for measuring value in R&D projects, we can say that although some work has been done, most results refer to collaborative university-industry projects and not to other types of R&D projects implemented at universities, where no cooperation with industry takes place. Moreover, the results do not always treat directly the notion of value but rather concepts such as performance or success, often without a clear definition. Today, it is widely accepted that value is the most important aspect in implementing successful R&D projects. For this reason, in the next section, we present the results of a survey aimed at identifying metrics that might be useful for measuring the achievement of value in R&D projects implemented at universities.

4. Results of the study of metrics in research projects

4.1. Research methodology and research sample

The study aimed to find out the opinions of project managers on the use of metrics to manage research projects in universities. For the purpose of research, a qualitative research strategy was applied – case studies. A method typical of qualitative research, i.e. interviews, was used to collect information on the use of metrics in research project management. Individual in-depth interviews (IDI) were conducted with 3 project managers. The interviews were in a structured format: the questions were prepared in advance and asked to the respondent in a set order. This is in line with the recommendation of R.K. Yin (2015), according to which the development of a case study protocol (questionnaire) is important in preparation for data collection. The case study protocol (questionnaire) was prepared based on the results of a quantitative study previously conducted by the authors on the use of metrics in projects (Iwko et al., 2023). The interviews lasted approximately one hour and were conducted by a moderator via instant messaging between September and November 2023. Data were anonymized so that the respondent could not be identified.

4.2. Results and conclusions

The metrics that were investigated related to various aspects of research project management, for example: resource utilization, progress towards objectives, costs and profits, customer satisfaction or the project team. On the basis of literature review, 34 potential metrics supporting project management were identified. The metrics were divided into four groups according to the areas they address and their level of difficulty. The first group is quantitative metrics, easily determined (Group 1), the second group – qualitative, but fairly easily understandable metrics completed by team members (Group 2), the third group – 'difficult' metrics (Group 3), the fourth group – metrics concerning the client (optionally, if they are a stakeholder in the project) (Group 4). Table 2 shows the types of metrics by group and their application in the surveyed organizations conducting research projects.

Table 2.
Results of the survey of metrics used in research project management by groups

	Interview 1	**Interview 2**	**Interview 3**
Group 1: quantitative, easily determined metrics			
Number of resources allocated in relation to planned resources	currently does not use, would like as % of available time	not used, too much volatility	usually uses, zero-one (are there or are not there)
Quality of allocated resources in relation to planned quality	uses (whether it is fit for purpose)	does not use	does not use, difficult to define
Number of hours (tasks) without human resources allocated	uses frequently	does not use	does not use
Percentage of total overtime worked	does not use	does not use	does not use

Cont. table 2.

Cost variance	uses frequently	uses frequently	uses frequently
Schedule deviation	uses frequently	uses frequently	uses frequently
Number of changes to the project scope	did not use, but considers important	does not use	does not use
The extent to which it has been possible to invoice and obtain payment on time	controlled by an external body (e.g. finance department)	controlled by an external body (e.g. finance department)	controlled by an external body (e.g. finance department)
Quality of supplier monitoring (supplier relations)	considers important, qualitative metrics	does not use	does not use, difficult to define
Number of cost adjustments made	did not use, but considers important	not used, too much volatility	not used, too much volatility
Quality of implementation of the risk management plan	does not use, but it is worth checking	does not use	does not use, difficult to define
Number of tasks (work packages) completed according to plan	did not use, but considers important	does not use	does not use
Group 2: Qualitative, easy to understand metrics completed by team members			
Amount of wasted/unproductive time	does not use	does not use	does not use
Quality of project management by the project manager	did not use, but considers important	not used, difficult to monitor	not used, difficult to monitor
Opportunities for personal and professional development of team members	does not use	does not use	does not use
The degree to which the opinions of individual project team members were taken into account	does not use	did not use, but considers important	does not use
Quality of definition and communication of roles to individual project team members	does not use	does not use	does not use
Group 3: "Difficult" metrics			
Project complexity index	difficult to define	does not use	uses in the 0-1 form
Number of critical restrictions	it is important to know them	does not use, difficult to define	does not use, not understood
Number of critical assumptions	used, but at the planning stage	does not use, but could	not used, not understood
Cost efficiency ratio	uses	monitored top-down, with the participation of the respondent	does not use
Schedule performance indicator	not used, but important, although it may be used in different ways	not used, difficult to monitor	does not use
Degree of implementation of health and safety rules	no data available	not applicable	does not use, difficult to define
Compliance with agreed quality indicators	uses	does not use	uses in the 0-1 form
Group 4: Customer-related metrics			
Level of customer satisfaction with the project outcome	no data available	does not use	uses occasionally
Level of customer satisfaction with the project	no data available	not used, difficult to monitor	depends on the customer, uses occasionally
Level of customer satisfaction with project communication	no data available	not used, difficult to monitor	depends on the customer, uses occasionally

Cont. table 2.

Number of commitments kept to the customer as a proportion of total commitments	no data available	not used, difficult to monitor	depends on the customer, uses occasionally
Quality of customer expectation management	no data available	not used, difficult to monitor	depends on the customer, uses occasionally
Level of understanding of the client and their industry by the project team	no data available	not used, difficult to monitor	depends on the customer, uses occasionally
The extent to which the project team looked after the client's interests	no data available	not used, difficult to monitor	depends on the customer, uses occasionally
The extent to which the project has contributed to establishing or strengthening the company's position in the industry (additional opportunity generation)	no data available	not used, difficult to monitor	depends on the customer, uses occasionally

Source: own elaboration.

The application of the protocol (questionnaire) to the multiple holistic case study allowed the following general conclusions to be drawn:

- Frequent adaptation of metrics to specific project needs. It has been pointed out that some metrics, while effective in one project, may not be practical in another, especially for projects funded by large institutions or authorities. This is because such institutions impose a set of metrics and indicators that are required to be monitored by the project manager.
- Preferences varied as to the type of metrics. Some respondents clearly preferred qualitative, descriptive metrics, difficult to capture in the form of surveys or project management tools. In contrast, those dealing with large externally funded projects showed a preference for quantitative metrics, easy to monitor and giving a sense of control to beneficiaries.
- Regardless of the nature of the projects, the most frequently mentioned metrics were those related to the effective use of resources, especially financial resources. Controlling expenditure levels remains a key element of project monitoring.
- Metrics related to health and safety policies, or risk planning, were the least frequently used. Respondents indicated that these issues are often handled by specialists outside the project teams.
- A metric that did not apply to the projects of any of the people interviewed was the control of overtime. This applied to people from both business and academic institutions. Individuals from project teams are not billed on an hourly basis, and even those on a full-time basis do not have a practice of accounting for overtime in the workplace.
- Metrics related to the monitoring of financial aspects are used by specialised individuals or departments, not by project managers.

- Most of the metrics reported by respondents were monitored reactively, in response to current events and problems in project implementation. The responsibility for monitoring these metrics was often due to unforeseen situations or guidelines from the institutions/project funders.
- Failure to use certain metrics did not mean that respondents considered the corresponding issues irrelevant. It was indicated that it was important to monitor these areas and that metrics could serve as a tool to support memory.

In summary, respondents appreciated the potential of metrics to increase the effectiveness of research project management and to create good practice but noted that some metrics (also used in the quantitative survey (Iwko et al., 2023) are not well understood and need to be clarified to become a useful element in research project management.

5. Proposal of metrics to be used in R&D projects implemented at universities in the context of project value

Eckes-Kondak (2021) proposed a list of values desired by various stakeholders of R&D projects implemented at universities. These values are presented in Table 3.

Table 3.
Values desired to be achieved in research and development projects conducted at universities

Types of value			
material	**non-material**		
	professional	**psychological**	**social**
Compensation from the project, functional remuneration for managing the project, profit (or indirect profit) from the sale (or leasing) of new technology, additional remuneration for employees, salary bonuses, bonuses for employees, additional remuneration for employees from the project, acquisition of new research equipment, profits from leasing research equipment, indirect revenues, profit (or indirect profit) from the implementation of new technology, increase in base salary, awards, increase in internal funding for the unit, increase in external funding for the unit, revenue from the sale of new technology, revenue from cost reductions or simplification of production processes, increase in the total value of the enterprise.	Gaining professional experience through performing managerial functions, improving the qualifications of one's employees, affiliation with published scientific articles, gaining professional experience through publishing scientific papers, career advancement, obtaining an academic title, improving the qualifications of one's employees, achieving a better result in categorization, creating opportunities for the development and dissemination of new technology (spin-off), creating opportunities for the development and dissemination of new technology (spin-out).	Gaining new experiences, enriching skills and personal development, enhancing employee skills, establishing new business relationships, building the brand of products or services, social advancement, prestige, recognition, prestige for the unit, gaining new experiences, prestige for enterprises, increasing enterprise innovation, higher market position.	Enabling the research team to fulfill their professional aspirations, creating the project's goal as a response to societal or market needs, shaping intellectual capital, providing public access to scientific publications, making new technology available as a response to societal or market needs, indirect participation in creating opportunities for new knowledge, improving quality of life, simplifying production processes, indirect participation in creating opportunities for new knowledge, indirect participation in improving quality of life, simplifying production processes.

Source: own elaboration based on Eckes-Kondak, 2021.

If we juxtapose Table 3 with Table 2, we can observe a discrepancy between them. Most metrics proposed in the literature, including those evaluated as useful by the study participants, do not align with the values desired by the stakeholders of R&D projects implemented at universities. This indicates that further research is needed to reconcile the two tables. While it is true that the participants of the study acknowledged that some metrics might be useful, they are not suited for measuring the likelihood of achieving the desired values. To measure this aspect, at least the metrics from Groups 2, 3, and 4 should be utilized. However, in the study, practically none of the respondents expressed interest in these metrics.

The next step should therefore involve implementing metrics from Groups 2, 3, and 4 at universities and persuading project managers that these metrics could be useful for controlling whether their projects are progressing in the desired direction.

6. Conclusions

In this paper, our starting point is two statements that are generally accepted today in the field of Project Management:

- A project is successful only if it delivers the values expected from it by the key stakeholders.
- It is possible, at least to some extent, to measure during project implementation the likelihood of achieving these values.

We applied these statements to R&D research projects implemented at universities. We conducted a literature review, which revealed that research on metrics for measuring the likelihood of achieving values in R&D projects is largely limited to industry-academia projects, does not encompass other types of projects, and often does not refer directly to values but rather to concepts such as performance.

Additionally, we carried out qualitative, interview-based research with R&D project managers from three universities. We asked them about their use of specific metrics identified in the literature. The results indicate that the metrics currently used do not effectively measure the likelihood of achieving the most important values expected by stakeholders in R&D projects implemented at universities.

Considering the low maturity of universities in project management, we propose implementing several metrics (Groups 2,3, and 4 in Table 2, new metrics should be proposed too) in the R&D project management process at universities on an obligatory basis. These metrics should be clearly linked to the values that R&D project managers aim to achieve, such as gaining new experiences, enriching skills and personal development, enhancing employee skills, establishing new business relationships, enabling the research team to fulfil their professional aspirations, and obtaining an academic title (a full list is provided in the

paper). The results should be monitored, and feedback from project managers should be collected to improve the system and increase its acceptance rate. Such measures will contribute to a higher success rate for R&D projects implemented at universities and greater satisfaction among project managers and team members.

Acknowledgement

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APPLICATION OF THE GORDON-SHAPIRO VALUATION MODEL FOR DIVIDEND COMPANIES LISTED ON THE POLISH AND AMERICAN STOCK EXCHANGES FOR THE PERIOD 2017-2023

Bartłomiej JABŁOŃSKI[1*], Dorota KIKA[2]

[1] University of Economics in Katowice; bartlomiej.jablonski@ue.katowice.pl, ORCID: 0000-0002-9398-017X
[2] University of Economics in Katowice; dorota.kika@ue.katowice.pl, ORCID: 0000-0001-5628-4709
* Correspondence author

Purpose: The purpose of this article is to reveal, how issuers, that are components of the WIG and S&P500 indices, paid dividends in 2017-2023, and to evaluate the effectiveness of investing in selected dividend-paying companies using the single-stage Gordon-Shapiro model.
Design/methodology/approach: The article analyzes each of the 30 dividend companies included in the WIG and S&P500 indices, that had the largest market capitalization at the end of 2017. The authors used comparative-descriptive methods and statistical data analysis to examine the differences between selected Polish and U.S. dividend-paying companies in 2017-2023. Stock valuation using the classical form of the Gordon-Shapiro model used the R^2 coefficient of determination and linear regression.
Findings: The results of empirical studies comparing Polish and U.S. dividend companies confirmed, that the latter are characterized by greater stability and systematically transfer profits to stockholders. Moreover, if, during the period under review, Polish companies paid dividends characterized by a higher rate of change, this was, at the same time, accompanied by a higher volatility of payments. In addition, the application of the classical Gordon-Shapiro model to stock valuation has proved problematic in both markets, due to the model's overly stringent assumptions, which are difficult to meet in practice. In the Polish market, no valuation according to the model could be carried out, while in the U.S., a valuation was carried out only for 9 out of 24 companies, but even then, there were significant discrepancies between the model valuation and the market valuation.
Research limitations/implications: Some limitations of the research should be noted, especially with regard to the number of dividend companies analyzed and the time range of the analyses. The authors plan to expand the study in the future to include a broader dataset, allowing for more comprehensive recommendations for investors on choosing companies and listing markets.
Practical implications: Expanding knowledge in building investment portfolios, that include dividend companies, and evaluating investment efficiency using the Gordon-Shapiro model. In addition, knowledge of the dividend payment policies of companies listed on various stock exchanges is very important for both investors and investment fund managements, as this allows them to make better investment decisions, as to where to make efficient equity investments.

Social implications: Among the article's social implications, the most important seems to be a possible change in investors' attitudes toward dividend companies and an increase in their knowledge of valuation using the Gordon-Shapiro model.
Originality/value: The article undertakes a stock valuation using the Gordon-Shapiro Dividend Discount Model for the period 2017-2023. In addition, investments in dividend stocks in the Polish and U.S. markets were compared, taking into account the companies with the largest market capitalization from the WIG and S&P500 indices.
Keywords: dividend-paying company, Dividend Discount Models, Gordon-Shapiro model, stock valuation.
Category of the paper: Research paper.

1. Introduction

The transfer of the value generated by the company to investors is of significant importance, especially from the point of view of theories on corporate value management (R. Litzenberger, K. Ramaswamy, M. Miller, F. Modigliani, M. Gordon, J. Lintner). The primary method of sharing value with stockholders is the payment of dividends. The method of distribution of financial results and changes in the amount of dividends paid perform an important informational function in the issuer's opinion. Therefore, the announcement of the dividend policy and its execution should be included among the basic tasks in the process of company management, which significantly affect the stock price (studies in this regard have been conducted by, among others: S. Desmukh, A.M. Goel and K.M. Howe, P. Asquith and D.W. Mullins Jr, M. Lichtenfeld, H. Rubin and C. Spaht II, M. Skousen) and changes in attitudes of capital market investors (research results published, among others, by P. Asquith and D.W. Mullins Jr, M. Baker and J. Wurgler, P., J.R. Woolridge and C. Ghosh, as well as D.J. Skinner and E.F. Soltes).

One of the most important elements of evaluating and selecting stocks of listed companies for an investment portfolio is to perform their current valuation. In the case of dividend companies, the most popular and widely used stock valuation methods are dividend discount models (considerations in this regard were conducted, among others, by J.B. Williams, M.J. Gordon, E. Shapiro, S.E. Guild, B.G. Malkiel, C.C. Holt, E.F. Brigham, J.L. Pappas, N. Molodovsky, C. May, S. Chottiner, R.J. Fuller and C.-C. Hsia). Discount models are mainly based on dividend analysis, since, as J.B. Williams (1956, pp. 3-4) pointed out, "the longer a purchaser holds a stock or bond, the more important are the dividends or interest received, and the less important is the price achieved at the time of sale". Therefore, the effect of the discount selling price in a long-term investment on the intrinsic value of the stock is small ($\lim_{n\to\infty} \frac{P_n}{(1+r)^n} = 0$) – the discounting process and the significant number of years contribute to this. This article assumes, that the stock of dividend companies purchased by investors will not be sold, and will be valued using the Gordon-Shapiro model.

The purpose of the article is to reveal, on the one hand, how issuers, that are components of the WIG and S&P500 indices, paid dividends in 2017-2023 (whether they were characterized by positive dynamics of change and the level of volatility of dividends paid) and, on the other hand, to assess the effectiveness of investing in selected dividend-paying companies using the single-stage Gordon-Shapiro model.

The research carried out refers, with its scope, to companies in the WIG and S&P500 indices, that paid dividends in the 2017-2023 period (changes for the 2018-2023 period), with the possibility of not paying dividends once, due to the SARS-CoV-2 pandemic. The calculations were made in MS Excel software.

2. Literature review and research hypotheses development

P. Asquith and D.W. Mullins Jr. (Asquith, Mullins, 1983) indicate that, when investing in dividend companies, it is important for investors, that the issuer pays dividends with a positive growth rate on a continuous basis. On the other hand, A. Cwynar and W. Cwynar (Cwynar, Cwynar, 2007) and M. Kowerski (Kowerski, 2011) point out, that the investor's income, in the form of expected dividends, is more important than the expected gain from the sale of stock, because the dividend is certain, while the possible gains from an increase in the stock price are uncertain. Therefore, one of the basic criteria for investing in stock of public companies should be the systematic distribution of financial results to stockholders. Studies conducted by H. Rubin and C. Spaht II (Rubin, Spaht, 2011, pp. 11-19), A. Williams and M. Miller (Williams, Miller, 2013, pp. 58-69), as well as K.P. Fuller and M.A. Goldstein (Fuller, Goldstein, 2011, pp. 457-473) confirm the legitimacy of such investments. The mere fact of paying dividends has consequences for both the company itself and stockholders. Therefore, the dividends paid by issuers, in light of the theory and the research conducted, on the one hand, remain in relation to the value of the company (dividends determine the value of the company) and, on the other hand, depending on the dividend payment strategy adopted, affect the behavior of capital market investors (the dividend policy adopted determines the behavior of investors). Three theories of the determination of a company's value by the level of dividends paid are characterized in the literature. The conservative (pro-dividend) group assumes, that the value of the company will be maximized by a high rate of dividend payments (M. Gordon and J. Lintner). It is assumed, that dividends have always been and continue to be the most desirable form of receiving income from capital invested in stock, as the payment itself is certain, while capital gains are uncertain. Different beliefs are represented by R. Litzenberger and K. Ramaswamy, as representatives of the radical (anti-dividend) group, who recognize, that an increase in dividend payments reduces the value of the company, since stockholders attach considerable importance to taxes. For this reason, investors will prefer capital gains until

the taxation of profits from the sale of stock is lower than the level of taxation on dividends paid. On the other hand, the middle group (represented by M. Miller and F. Modigliani), called neutral, assumes that the dividend policy has no effect on either the stock price or the entity's cost of capital.

Regarding the strategies used by issuers to pay dividends, a review of the literature in this area reveals not only the diversity of approaches, but also the complexity of their application, since, depending on the strategy adopted, more or less consideration is given to factors, that affect future dividends (Brigham, Houston, 2015, p. 204; Brealey, Myers, 2003, p. 438; Baker et al., 2002; Duraj, 2002, p. 93; Benninga, Sarig, 2000, p. 285; Baker, Powell, Veit, 2002; Wilimowska, Wilimowski, 2001, pp. 452-453). Among the most important are:

- stable dividend payout ratio strategy – the company pays out a fixed percentage of its profits in the form of dividends,
- stable dividend strategy – the company pays a dividend, that is constant over time, thus avoiding changing it over short periods,
- surplus (so-called residual) dividend strategy – dividends are paid from the amount remaining after implementation of all approved projects,
- strategy of paying out the total profit – a strategy, that is difficult for the company to execute in the long term, due to the continuous transfer of high amounts without taking into account the development needs of the entity,
- a compromise strategy of a fixed dividend amount and an irregular additional one, depending on the company's current earnings,
- zero dividend strategy – the company does not pay dividends.

Taking into account the mentioned theories of the determination of the company's value by the level of dividends paid, as well as strategies for its payment, one can find proposals in the literature, that may provide some solution to the above controversies and dilemmas. One of them is the target payout ratio proposed by A. Damodaran (Cwynar, Cwynar, 2007, p. 213; Damodaran, 2007, p. 1017; Szablewski, Tuzimek, 2007, p. 51). The author assumes, that the company should set a target and valid long-term payout ratio. Adjustments, if any, can be made by paying additional dividends or using buy-back, and the analysis of dividend policy should consist of the following steps:

1. Indicating what kind of net cash flow the company has generated in the past and the level of cash transfer to stockholders (dividend payments and buy-back).
2. Evaluating the results of ongoing investment projects, as measured by the ratio of return on equity and total invested capital to the cost of capital and weighted average cost of capital (WACC).
3. Determining what new investment projects the entity is planning from the point of view of creating stockholder value.
4. Deciding on:

a. limiting dividend payments when the company has made sound investment choices in the past and has favorable investment projects for the future,
b. paying dividends when the company has made wrong investment choices in the past and there are no effective investment projects.

Other ways of determining the dividend payout ratio can also be seen in the literature. Depending on the approach, indicators relating to FCFE (Cwynar, Cwynar, 2007, p. 214), net profit (Brigham, Houston, 2005, p. 207) or investment estimate budget and retained earnings are adopted (Wilimowska, Wilimowski, 2001, p. 463). Particularly interesting is the proposal presented by E.F. Brigham and J.F. Houston (Brigham, Houston, 2005, pp. 203-204) for the residual dividend policy, which the authors believe should be a function of four variables: investors' preference for choosing between dividends received and capital gains, the entity's investment capabilities, the target capital structure, and the availability of external capital. In contrast, J. Lintner's model (Brealey, Myers, 2003, p. 579) suggests, that dividends depend, in part, on a company's current profits and, in part, also on dividends paid in the previous year. In light of the mentioned theories related to the issue of the impact of the amount of dividends paid on the value of the company and on the behavior of investors, dividend discount models seem particularly relevant and interesting.

The first attempts to value stocks using Dividend Discount Models (*DDM*) took place as early as the beginning of the 20th century, although it wasn't until half a century later, that they gained popularity among investors, who began to develop and apply them en masse. Discount models of stock valuation are based on the analysis of dividends, which are the basis for assessing the effectiveness of the investment for the investor from holding stock (Pera, Buła, Mitrenga, 2014, p. 71).

In the stock valuation process, an investor's primary goal is to determine the current price of a stock at a given point in time by determining its intrinsic value (IV). As defined by S.E. Guild (1931, p. 43), the intrinsic value of a stock is the sum of the discount payments we expect to receive in the future. In view of this, the purchaser of the stock is entitled to the benefits of its sale, as well as the profits in the form of dividends from holding it, which, simplifying, can be written using the formula:

$$IV_0 = \sum_{t=1}^{n} \frac{DIV_t}{(1+r)^t} + \frac{P_n}{(1+r)^n},$$

where:

IV_0 – the intrinsic value of the stock at the current time,

DIV_t – dividend per stock paid at the end of year t,

P_n – stock sales price,

r – required rate of return on stocks, taking into account three elements, i.e. the real rate of return, expected inflation and risk.

If the purchaser of stock does not intend to sell it, the value of the stock is determined solely by the stream of dividends received (Zarzecki, 1999, p. 98).

The literature distinguishes several versions of dividend discount models, namely the constant dividend value model and the logistic dividend growth model (Williams, 1956, pp. 77-80, 89-96), the finite dividend model and the constant dividend growth rate model – otherwise known as the Gordon-Shapiro model – (Gordon, 1962; Gordon, Shapiro, 1956, pp. 102-110), two-stage models (Guild, 1931, pp. 66-84, 265-273; Malkiel, 1963, pp. 1004-1031; Holt, 1962, pp. 465-475; Brigham, Pappas, 1966, p. 158; Fuller, Hsia, 1984, p. 51), three-stage models (Molodovsky, May, Chottiner, pp. 104-123), as well as bimodal models (Fernandez, 2002, p. 118 et seq.; Hurley, Johnson, 1994, pp. 5-54). In this article, research was conducted for the oldest and the most widely used model in developed markets, the Gordon-Shapiro model. Figure 1 shows several scenarios for the development of future dividends for PZU under the aforementioned models.

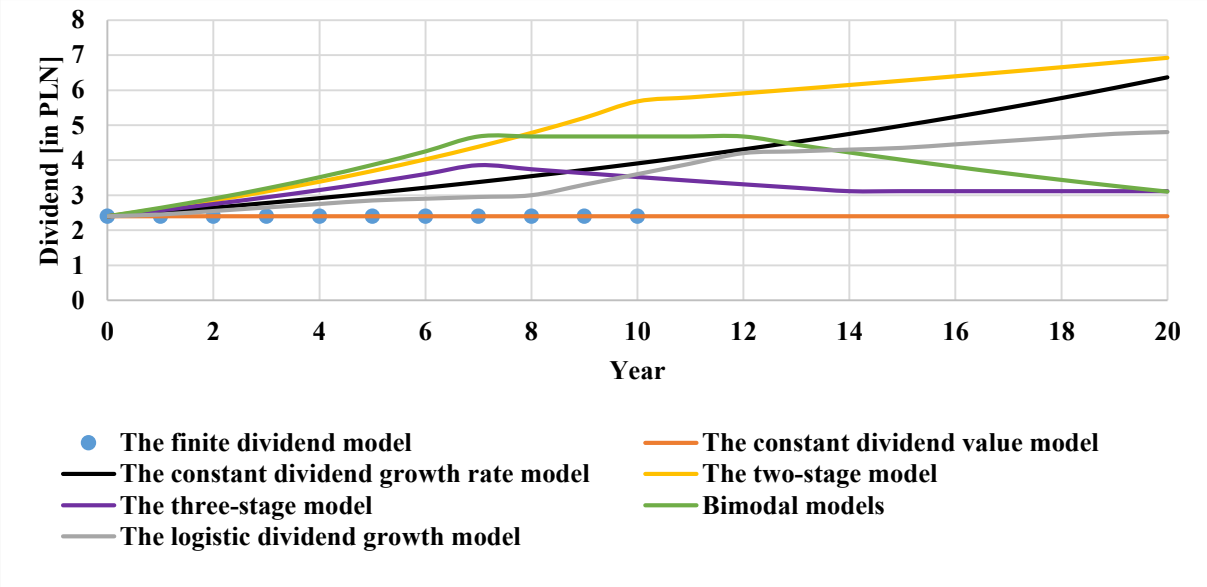

Figure 1. Scenarios of future dividends for PZU company, according to different dividend discount models.

Source: Own study.

The constant dividend growth rate model is used to determine the relevant stock price at a given point in time (IV), and then compare it to the market price (P_0). Taking into account the relationship between the current market price of a stock and its intrinsic value, the stock was divided into: undervalued stocks ($P_0<IV$), overvalued stocks ($P_0>IV$) and properly valued stocks ($P_0=IV$). If the current stock price is determined solely by the level of future dividends (ref. $DIV=DIV_1=DIV_2=...=DIV_\infty$) and the required rate of return, the aforementioned fixed dividend model should be considered (Williams, 1956, pp. 76-77):

$$P_0 = \sum_{t=1}^{\infty} \frac{DIV}{(1+r)^t} = \frac{DIV}{r},$$

where DIV – expected dividends.

The Gordon-Shapiro model takes into account the fact, that profitable companies reinvesting retained earnings can pay higher dividends in the future than before. Thus, Gordon's model is based on two basic assumptions:

1. Dividends are paid every year (indefinitely).
2. The dividend paid to the company's stockholders is growing at a constant rate over time, which means that:

$$DIV_t = DIV_{t-1}(1 + g_t) ,$$

where g – dividend growth rate in year t.

In practice, a serious problem is the proper determination of the g parameter. Citing J.B. Williams and assuming, that the return on assets, income tax rate, cost of debt, profit retention ratio and financing structure are unchanged, g can be written as (K. Jajuga, T. Jajuga, 2015, p. 161):

$$g = ROE \cdot f ,$$

where:
ROE – return on equity,
f – retention rate (RR), calculated as the quotient of retained earnings and net income.

The literature often emphasizes, that dividend growth rates in developed markets are in the range of 5-8% per year. This is because the Gordon-Shapiro model applies primarily to companies in a mature growth phase, where the growth of their dividends is expected to be linked to the growth rate of GDP (real + inflation) (Brigham, Houston, 2015, p. 381).

Assuming, following J.B. Williams (1956, pp. 128-135), that the dividend growth rate is constant at g and, at the same time, is lower than the cost of equity, i.e. $g < r$, the value of stock can be estimated as follows (Panfil, Szablewski, 2006, pp. 300-302):

$$P_0 = \sum_{t=1}^{\infty} \frac{DIV_0(1+g)^t}{(1+r)^t} = \frac{DIV_0(1+g)}{r-g} = \frac{DIV_1}{r-g} .$$

The Gordon-Shapiro model can also be used to estimate the required rate of return based on the current market price of stock:

$$r = \frac{DIV_0\,(1+g)}{P_0} + g = \frac{DIV_1}{P_0} + g .$$

It should be noted, that the constant dividend growth model does not examine the relationship between dividends and stock value. Although the studies of M.J. Gordon (1959, pp. 99-105) and J. Lintner (1956, pp. 49-95) referred to the analysis of market data and allowed the formulation of the hypothesis of a positive relationship between dividends and stock prices (the "bird in the hand" theory).

Based on the literature review and the identified research gaps, the following research hypotheses were defined:

H_1: The average rate of change in dividends paid by dividend companies included in the WIG index is higher than the same measure characterizing companies that are components of the S&P500 index.

H_2: The standard deviation of the rate of change of dividends is lower for U.S. dividend companies than for dividend companies in the WIG index.

H_3: The use of the classical form of the Gordon-Shapiro model for stock valuation does not allow a reliable assessment and proper selection of listed companies for an investment portfolio.

A description of the research sample and research methodology is included in the next section of the paper.

3. Sample selection and methodology

For the purpose of conducting the research, the research sample was selected so as to provide, on the one hand, the broadest possible view of the issue at hand (the issues discussed concern only dividend companies) and, on the other hand, it should take into account the possibilities in terms of data availability and quality. Therefore, the authors decided to compare two markets that, from the point of view of the history of dividend payments by listed issuers, are significantly different. In the first stage of the research, the authors set themselves the goal of comparing the U.S. market, which is particularly developed in terms of dividend payment traditions, with the Polish capital market, the selected dividend companies of which are trying to emulate the best global practices in terms of transferring a portion of profit to stockholders. For this purpose, when analyzing the Polish market, the 30 largest companies included in the WIG index were taken into account. Similarly, analyses of the U.S. market were based on 30 entities from the S&P500 index (this was the first criterion for selecting companies). In both cases, these were the companies with the largest market capitalization at the end of 2017. Companies classified in the study, that are components of the WIG index, are Alior, Amrest, Assecopol, BgzBnpp, Budimex, BzWbk (now as Santander), Ccc, Cyfrplsat, Enea, Energa, Eurocash, GrupaAzoty, Handlowy, Ingbsk, Kghm, Lotos, Lpp, Mbank, Millenium, OrangePl, Pekao, Pge, Pgnig, PknOrlen, PkoBp, Pulawy, Pzu, Synthos, TauronPe and Żywiec. In turn, the selected issuers from the S&P500 index are Alphabet Inc. Class A, Alphabet Inc. Class C, Amazon.com Inc., Apple Inc., AT&T Inc., Bank of America Corporation, Berkshire Hathaway Inc. Class B, Chevron Corporation, Cisco Systems Inc., Coca-Cola Company, Comcast Corporation Class A, Exxon Mobil Corporation, Facebook Inc. Class A, General Electric Company, Home Depot Inc., Intel Corporation, Johnson & Johnson, JPMorgan Chase

& Co., Merck & Co. Inc., Microsoft Corporation, Oracle, PepsiCo Inc., Pfizer Inc., Philip Morris International Inc., Procter & Gamble Company, Verizon Communications Inc., Visa Inc. Class A, Wal Mart, Walt Disney Company and Wells Fargo & Company.

For the purposes of the research, dividend companies were classified as those, that paid dividends continuously for the period 2017-2022 during 2018-2023 (this was the second criterion for selecting companies, and it was not influenced by whether dividends in a given year were paid on a one-time basis or, as in the case of the U.S. market, more frequently, as even quarterly). In addition, the study took into account the occurrence of the SARS-CoV2 pandemic during the period analyzed, which negatively affected the continuity of dividend payments. Therefore, consideration was given to the possibility of suspending dividend payments for a maximum of 1 year of the study's time range. For the selected companies, data on dividends paid, as well as stock price levels, were downloaded from stooq.pl and investing.com.

In the second stage of the research on stock valuation using the Gordon-Shapiro model, an important element was the determination of the expected dividend growth rate (g) and the rate of return attributable to the investor (r). Theoretically, dividend growth rates are assumed to be in the range of 5% in developed financial markets. In this study, the real dividend growth rate calculated on the basis of historical data (calculated year-on-year) was taken as the g value. In turn, according to one of the market efficiency hypotheses (Fama, 1970, pp. 384-417; 1991, pp. 1575-1617), an investor also expects an appropriate premium for the risk incurred. It is, therefore, necessary to consider, to what alternative investments an investor today relates the risks present in the stock market. At this stage of the research, the rate of return was set at 10% higher than 10-year Treasury bonds can generate. As of 01.01.2023, the interest rate on EDO0133 Polish bonds was 7.25%, so r was assumed at 7.98%. In contrast, the interest rate in the U.S. market was at 3.79%, so 4.17% was assumed. During the period under review, the geometric mean return for the entire Polish stock market for the period 2017-2023, i.e. the geometric mean return of the WIG index (r_{gWIG}), could not be taken as a point of reference, as it was negative (r_{gWIG} = -23.39%), due to the occurrence of the COVID-19 pandemic and the war caused by Russia's aggression against Ukraine in 2022. In contrast, the geometric mean for the U.S. stock market (S&P 500 index) was 11.19%.

A practical stock valuation using the classical form of the Gordon-Shapiro model used the R^2 coefficient of determination and linear regression, which was used to test, whether the dividends paid by each listed company were statistically at a similar level, which allows the Gordon model to be used with a constant dividend value.

The results of the research conducted are presented in the following point.

4. Analysis of the application of the Gordon-Shapiro valuation model for Polish and American dividend companies

In the analyzed period 2017-2023, there is a wide variation among the analyzed markets, not only in the number of dividend companies, but more importantly in the systematics of dividend payments. Of the 30 largest companies in the Polish market, only 4 paid dividends without a break (13.33% of the 30 issuers analyzed), and 5 issuers paid dividends with one break period (16.67%). For the U.S. market, as many as 80% of companies paid dividends continuously (Table 1).

Table 1.
Frequency structure of dividend payments by Polish and U.S. companies in 2017-2023 (%)

Percentage of companies that paid dividends	WIG	S&P500
0 years	20.00%	16.67%
1 year	10.00%	0.00%
2 years	10.00%	0.00%
3 years	6.67%	3.33%
4 years	6.67%	0.00%
5 years	16.67%	0.00%
6 years	16.67%	0.00%
7 years	13.33%	80.00%

Source: Own study.

It is also worth noting, that, already at the initial stage of the research, a significant variation is outlined between the companies in the WIG and S&P500 indices. Of the 30 largest U.S. companies selected, only 16.67% paid no dividends at all and 3.33% paid dividends for 3 years. Much greater variation in the systematics of dividend payments can be observed in the Polish market, since as many as 20% of the 30 companies analyzed did not pay dividends during the period. In addition, 10% of entities paid dividends in only 1 year or for 2 years, 6.67% paid dividends for 3 or 4 years, and a total of 33.33% of companies paid dividends for 5 or 6 years (Figure 2).

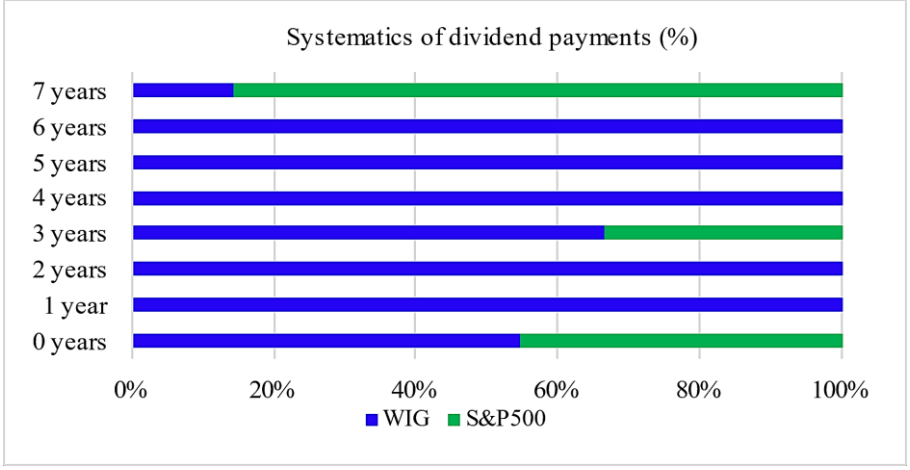

Figure 2. Systematics of dividend payments in the years 2017-2023 (%).

Source: Own study.

Following the formulated methodology of the next stage of the research, Assecopol, Budimex, BzWbk (now as Santander), Handlowy, Lpp, Pekao, PknOrlen, Pzu and Żywiec were considered dividend companies from the WIG index. In turn, the selected dividend issuers from the S&P500 index are Apple Inc., AT&T Inc., Bank of America Corporation, Chevron Corporation, Cisco Systems Inc., Coca-Cola Company, Comcast Corporation Class A, Exxon Mobil Corporation, General Electric Company, Home Depot Inc., Intel Corporation, Johnson & Johnson, JPMorgan Chase & Co., Merck & Co. Inc., Microsoft Corporation, Oracle, PepsiCo Inc., Pfizer Inc., Philip Morris International Inc., Procter & Gamble Company, Verizon Communications Inc., Visa Inc. Class A, WalMart and Wells Fargo & Company.

If the selected companies can be considered representative of dividend companies listed on the Polish and American stock exchanges, then from the point of view of the rate of change of dividend payments, the former can be pointed out to be more attractive. They are characterized by higher average changes in payouts between 2021 and 2023, as well as an increasing trend line (Figure 3).

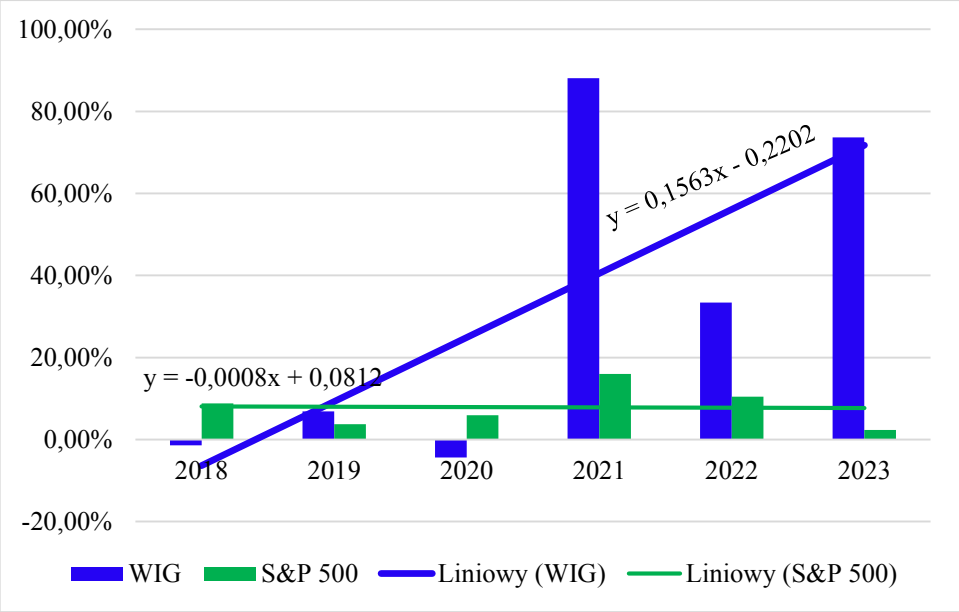

Figure 3. Trend line of the average rate of change of dividends for the period 2018-2023.
Source: Own study.

However, referring to selected statistics characterizing both groups of companies from the point of view of a capital market investor, the advantage of dividend companies from the S&P500 index becomes apparent. Not only are they characterized by a lower standard deviation of the average rate of change of dividends, but also there was no negative average rate of change and no negative median rate of change of dividends in each of the analyzed periods. Which is something different from Polish listed issuers (Table 2).

Table 2.
Selected statistics characterizing Polish and U.S. companies in 2018-2023 (%)

Groups of dividend companies	Measure	2018	2019	2020	2021	2022	2023
WIG	Average dividend change rate	-1.41%	6.86%	-4.39%	88.09%	33.35%	73.63%
	Standard deviation of the dividend change rate	29.05%	68.40%	80.96%	118.59%	112.81%	143.84%
	Median dividend change rate	-4.49%	5.68%	-27.62%	34.21%	0.00%	24.88%
S&P 500	Average dividend change rate	8.83%	3.77%	5.90%	15.96%	10.41%	2.30%
	Standard deviation of the dividend change rate	18.05%	22.84%	14.82%	72.27%	23.26%	14.30%
	Median dividend change rate	6.56%	6.06%	5.51%	5.43%	6.18%	4.47%

Source: Own study.

Dividend companies, that are components of the S&P500 index, were characterized by greater stability in payouts (lower average rate of dividend change and median rate of change), while having a lower standard deviation in each of the analyzed years from the 2018-2023 range. Moreover, over the period under review, Polish dividend companies were characterized by an upward trend in the standard deviation of the rate of dividend changes with a relatively stable trend for U.S. companies (Figure 4).

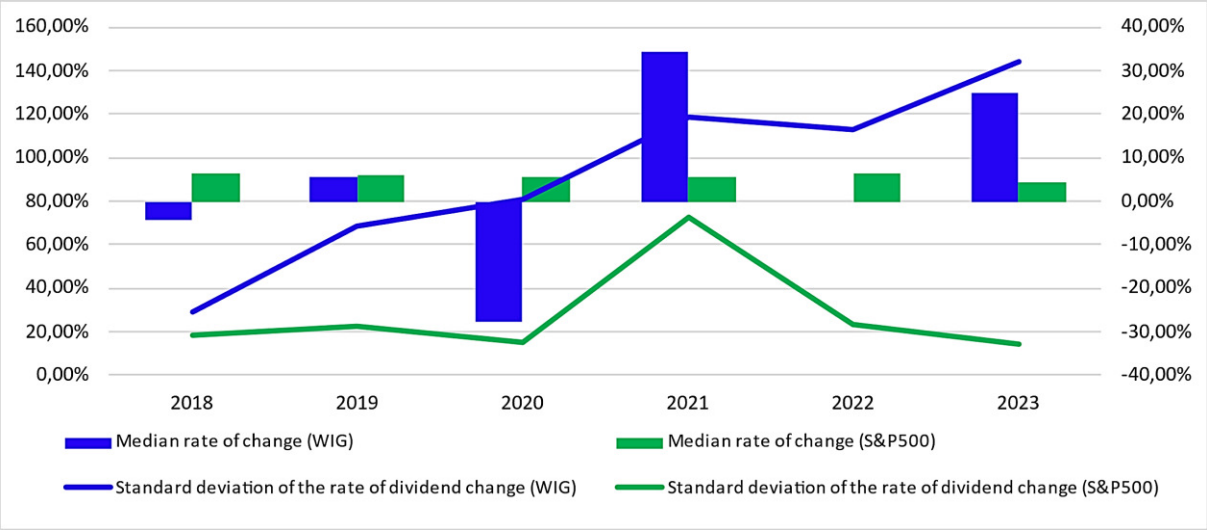

Figure 4. Standard deviation (left scale) and median (right scale) of the average rate of dividend change for the 2018-2023 period.

Source: Own study.

A summary of the first stage of the study is presented in Table 3. The calculations therein show that, if investors are counting on a higher average rate of dividend changes by Polish dividend companies (20.05 pp. higher), this will be associated with a higher average standard deviation of the rate of dividend changes by as much as 16.57 pp. This relationship is also confirmed by comparing for both groups of companies the average median rate of dividend

changes. For dividend companies in the WIG index, it is 17.43% and 5.86% for U.S. dividend issuers.

Table 3.
Average statistics characterizing Polish and U.S. companies in 2018-2023 (%)

Groups of dividend companies	Measure	For the period 2018-2023
WIG	Average dividend change rate	27.91%
	Standard deviation of the dividend change rate	25.97%
	Median dividend change rate	17.43%
S&P 500	Average dividend change rate	7.86%
	Standard deviation of the dividend change rate	9.40%
	Median dividend change rate	5.86%

Source: Own study.

In the next step, dividends paid were analyzed for valuation using the Gordon-Shapiro model. The first assumption is that companies pay non-zero dividends on a regular basis, while the second is that they should follow an exponential function (the dividend growth rate – *g* parameter – is and will always remain constant).

The study highlighted the shortcomings of the classical form of the Gordon-Shapiro model in the Polish market. 5 of the 9 WIG index companies examined did not pay dividends in each period, while for none of the 4 companies regularly paying dividends was it possible to determine a constant dividend growth rate. This means, that in no case did the exponential model fit the dividends paid by the companies well – see Figure 5. Failure to meet at least one of the basic assumptions of the classical dividend form of the Gordon model prevents the model from being used in practice. Therefore, in addition, a simple statistical analysis was referred to, abandoning complete adherence to the restrictive assumptions of the Gordon model, and a basic measure of the quality of model fit, the so-called coefficient of determination (R^2), was introduced into the analysis. The coefficient of determination indicates what proportion of the variation in the dependent variable (to what extent) was explained by the selected model. The R^2 coefficient takes values in the [0;1] interval, and uses the least squares method to estimate parameters. The model is best fit when $R^2 \geq 0.90$. In this context, the best-fit dividends, in terms of coefficient of determination, were those of Assecopol, with $R^2 = 0.7636$, while only a linear fit was possible for Santander, with $R^2 = 0.7081$. As a result, it was impossible to apply the classical form of the Gordon-Shapiro model to stock valuation for companies in the WIG index.

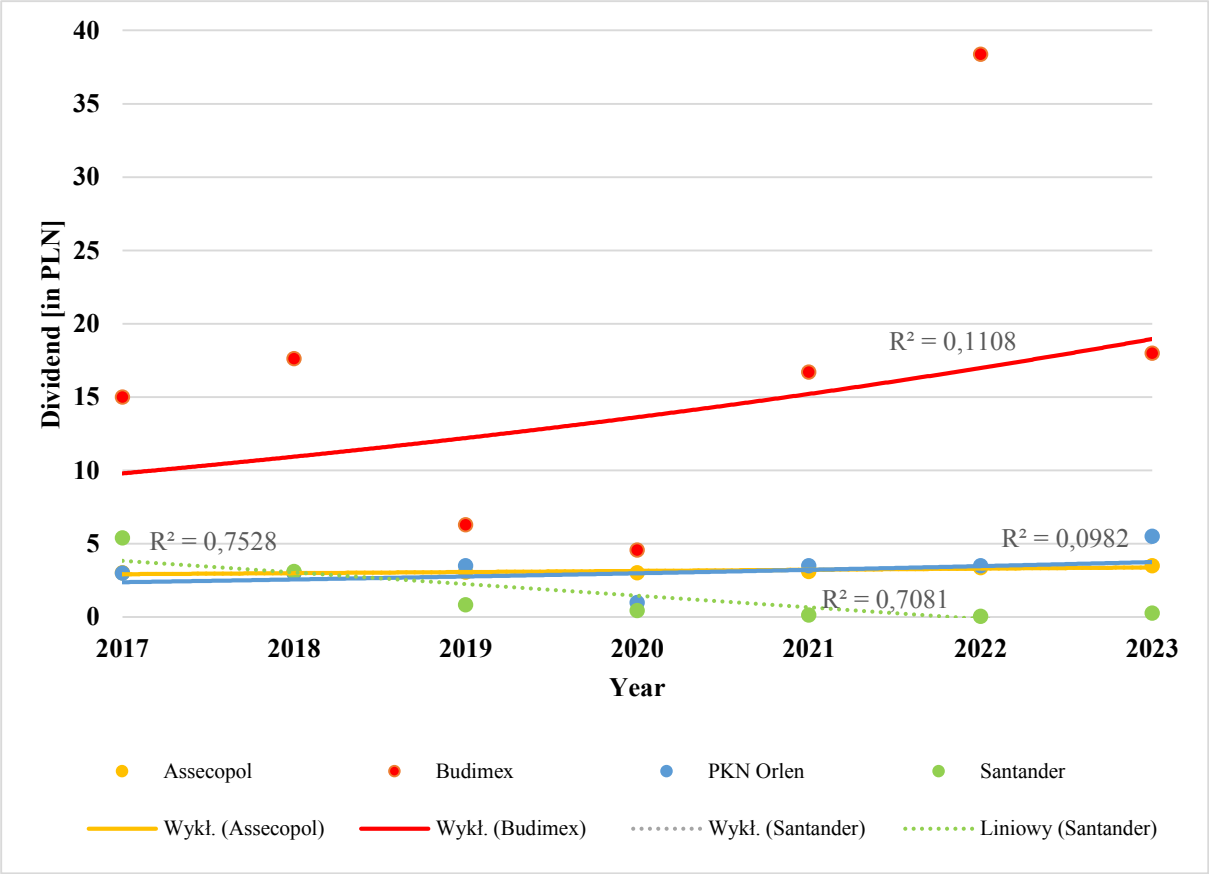

Figure 5. Dividends paid by Assecopol, Budimex, PKN Orlen and Santander in 2018-2023.
Source: Own study.

Rigorous application of the assumptions of the classical form of Gordon's model allows the model to be applied in practice for only two companies in the U.S. market, namely Verizon Communications and Walmart, whose dividend growth rate from 2017 to 2023 was 2%. For this reason, as in the case of the Polish stock market, the coefficient of determination (R^2) was used. Based on the observations, it was noted that for 13 companies, i.e. BAC, CVX, HD, JNJ, KO, MRK, MSFT, ORCL, PFE, PG, WMT, VZ, V, the coefficient of determination was higher than 0.9, which indicates a very good fit of dividends paid to the exponential model. The highest score, i.e. $R^2 = 0.99$, was achieved by Chevron, Johnson & Johnson, Microsoft, Verizon Communications, Visa and Walmart. This means that, although the dividends paid by these companies do not meet the Gordon model's second assumption of constant dividend growth (except for VZ and WMT), they are close to its execution. In the case of companies: CSCO, JPM, PEP, XOM, the coefficient of determination indicates a good fit of dividends to the model, that is $0.80 \leq R^2 < 0.90$. A satisfactory fit was observed for Comcast Corporation and Philip Morris, i.e. $0.60 \leq R^2 < 0.80$. In other cases, the fit was poor or unsatisfactory – $R^2 < 0.60$. Figure 6 presents the development of dividends paid by Microsoft with the exponential model fitted thereto (dividends are marked in blue, while the exponential function is shown as a solid blue line), and compares them with various theoretical variants of dividends

determined according to the Gordon model (dividends are marked in red, green and yellow, respectively, depending on the level of *g* adopted, while exponential functions are shown using a dashed line). For each of the theoretical variants, the coefficient of determination is 1.

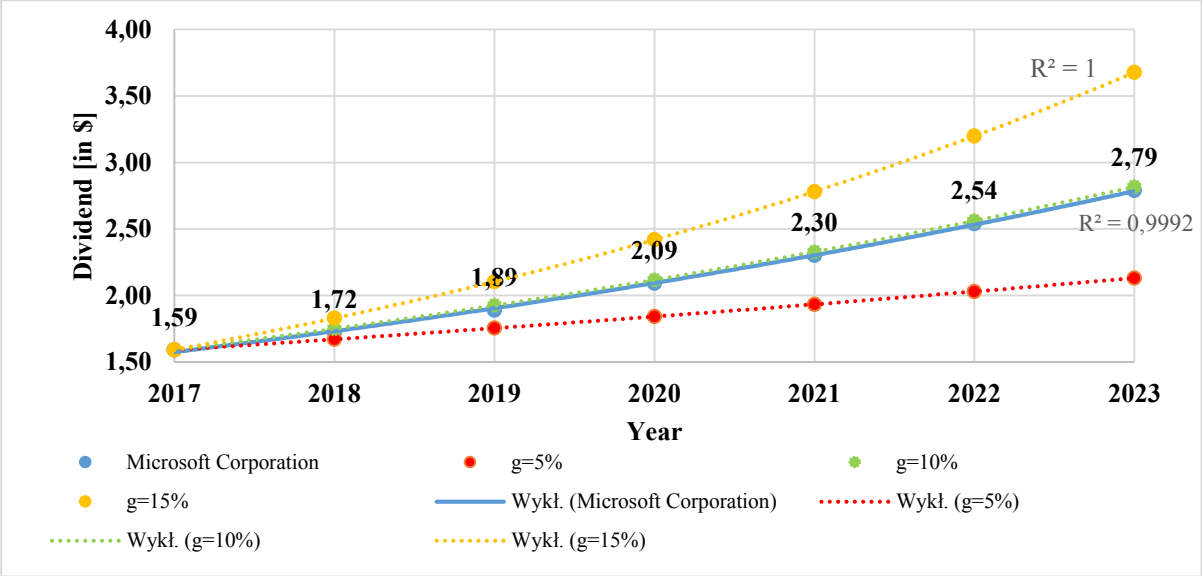

Figure 6. Dividend paid by Microsoft vs. dividend formation according to Gordon's model for $g = 5\%$, 10% and 15%.

Source: Own study.

For S&P500 companies with a coefficient of determination above 0.9, stock valuations were made using the Gordon-Shapiro model, assuming a dividend growth rate equal to the average rate of change of dividends in 2017-2023 – Table 4. The theoretical price was then compared with the market price as of 29.12.2023, and a signal was determined as to whether buy (K) or sell (S) stocks, if held. Finally, the K and S signals were verified by checking the behavior of the price of each stock at the end of June 2024.

The research showed that only for 9 companies (of which 3 in the two adopted variants for the *r* parameter) was it possible to value stocks according to the assumptions of the Gordon-Shapiro model. Interestingly, there was a buy signal in the valuation of KO, VZ and WMT stock, which was verified correctly by taking into account the stock market price of these stocks on 28.06.2024, when the investor accepted a rate of return 0.1 higher than that given by 10-year Treasury bonds. For most companies, only valuation under the second option was possible, where *r* was greater than *g* and estimated as the geometric mean return of the S&P500 index for the period 2017-2023. For all 9 companies, a sell signal was received for the stock, while only for JNJ and PFE did the forecast prove accurate, as the stock price on 28.06.2024 was lower than the price on the decision date, i.e., 29.12.2023. For the remaining companies, the valuation was not possible, as they did not meet the model's assumption of $r>g$. In summary, it can be concluded, that the discrepancies between the model valuation and the market prices of individual stocks are significant, which indicates the impossibility of making a correct stock valuation using the classical form of the Gordon-Shapiro model in practice.

Table 4.
Stock valuation according to the Gordon-Shapiro model and verification of the forecast for S&P500 index companies

Index	Company symbol	Stock valuation according to the Gordon-Shapiro model as of 29.12.2023 [in $] assuming:			Stock market closing price on 29.12.2023 [in $]	Buy [K]/ Sell [S] signal as of 29.12.2023		Forecast verification - stock market closing price on 28.06.2024 [in $]
		g [in %]	*10-year Treasury bonds + premium* r_{US}=4.17% [1]	*S&P500 index + premium* $r_{gS\&P500}$=11.19% [2]		[1]	[2]	
S&P500	BAC	16%	$r < g$	$r < g$	33.67	-	-	-
	CVX	6%	$r < g$	117.68	149.16	-	S	156.42
	HD	16%	$r < g$	$r < g$	346.55	-	-	-
	JNJ	6%	$r < g$	95.32	156.74	-	S	146.16
	KO	4%	408.29	25.48	58.93	K	S	63.65
	MRK	8%	$r < g$	94.22	109.02	-	S	123.80
	MSFT	10%	$r < g$	224.95	376.04	-	S	446.95
	ORCL	14%	$r < g$	$r < g$	105.43	-	-	-
	PFE	4.23%	$r < g$	24.56	28.79	-	S	27.98
	PG	5%	$r < g$	67.13	146.54	-	S	164.92
	V	18%	$r < g$	$r < g$	260.35	-	-	-
	VZ	2%	125.96	29.26	37.70	K	S	41.24
	WMT	2%	101.03	24.92	52.55	K	S	67.71

Source: Own study.

The absence among the companies in the WIG index of those that regularly pay dividends with a constant rate of growth inspired the authors to try to check, whether the dividends paid by the companies were not at a similar level (constant) during the period under research, which would make it possible to omit the g value from the calculations ($g = 0$). For this purpose, a statistical method was used to test the significance of the regression parameters of individual companies.

The significance level was assumed to be $\alpha = 0.05$. The significance of the individual regression parameters (β_i) was then evaluated to see, if changes in the explanatory variable x somehow explain variation in the dependent variable y. Hence, the following hypotheses of significance of the directional coefficient were tested:

$$H_0: \beta_i = 0,$$

$$H_1: \beta_i \neq 0,$$

where:

H_0 – Hypothesis H_0 means that the directional coefficient is 0,

H_1 – Hypothesis H_1 means that the directional coefficient is different than 0,

β_i – beta regression parameter, understood as the rate of change of the dividend.

The zero beta (hypothesis H_0 positively verified) implies the relative constancy of the price over time, which is derived from the constant level of dividends over time. A positive beta means a rising stock price over time, by definition resulting from rising dividends. By the same logic, negative beta in this view means declining dividends over time.

The test was then based on:

$$t = \frac{\hat{\beta}_i}{s\left(\hat{\beta}_i\right)},$$

where:

$\hat{\beta}_i$ – is the estimator of the regression parameter β_i,

$s\left(\hat{\beta}_i\right)$ – is an estimate of the estimator error $\hat{\beta}_i$.

The critical area of the test depends on the hypotheses adopted and was determined using a Student's t-distribution. Table 5 summarizes the results for companies in the WIG and S&P500 indices.

Table 5.
Test of significance of the regression parameters of the WIG and S&P500 index companies for the period 2017-2023

Index	Symbol	|t|	t_α	Hypothesis accepted/rejected
WIG	ACP	3.8477	0.9621	H_0 rejected
	BDX	1.0527	0.9621	H_0 rejected
	SPL	-3.4828	0.9621	H_0 rejected
	BHW	0.8583	0.9621	No grounds for H_0 rejection
	LPP	3.3138	0.9621	H_0 rejected
	PEO	-1.3893	0.9621	H_0 rejected
	PKN	1.2822	0.9621	H_0 rejected
	PZU	0.4012	0.9621	No grounds for H_0 rejection
	ZWC	-1.9781	0.9621	H_0 rejected
S&P500	AAPL	-3.1851	0.9621	H_0 rejected
	T	-1.0938	0.9621	H_0 rejected
	BAC	13.3111	0.9621	H_0 rejected
	CVX	20.9581	0.9621	H_0 rejected
	CSCO	7.3807	0.9621	H_0 rejected
	KO	15.6628	0.9621	H_0 rejected
	CMCSA	2.6791	0.9621	H_0 rejected
	XOM	6.8853	0.9621	H_0 rejected
	GE	-0.9614	0.9621	No grounds for H_0 rejection
	HD	23.4951	0.9621	H_0 rejected
	INTC	-0.2673	0.9621	No grounds for H_0 rejection
	JNJ	61.3572	0.9621	H_0 rejected
	JPM	6.6798	0.9621	H_0 rejected
	MRK	23.1384	0.9621	H_0 rejected
	MSFT	22.3651	0.9621	H_0 rejected
	ORCL	11.1148	0.9621	H_0 rejected
	PEP	4.2645	0.9621	H_0 rejected
	PFE	13.0236	0.9621	H_0 rejected
	PM	2.9301	0.9621	H_0 rejected
	PG	14.9244	0.9621	H_0 rejected
	VZ	1.28E+15	0.9621	H_0 rejected
	V	18.0284	0.9621	H_0 rejected
	WMT	1.45E+15	0.9621	H_0 rejected
	WFC	-1.5332	0.9621	H_0 rejected

Source: Own study.

Based on the results presented in Table 5 for the 4 companies in the WIG and S&P500 indices, i.e. BHW, PZU, GE and INTC, it was observed, that there were no grounds for rejecting the H_0 hypothesis, as $|t| < t_\alpha$. This means, that it is possible to assume, that the directional coefficient is equal to 0, that is, to assume, that dividends paid during the period under research were similar, constant. Statistically, it is assumed that dividends paid did not change ($g = 0$). In other cases $|t| > t_\alpha$, that is, the hypothesis H_0 should be rejected. It can even be argued, that the size of dividends paid has fluctuated – most of the companies in the WIG and S&P500 indices saw an increase in dividends paid between 2017 and 2023.

The results obtained confirm, that companies in the WIG index pay dividends in an unpredictable and diverse manner, without sticking to a strict dividend policy, while in the case of U.S. companies, dividends were increasing. Therefore, it is necessary to hypothesize, that the dividends paid by the companies under research change over time, except that no pattern can be clearly identified as to how they change.

Complementing the above considerations, the intrinsic value of stocks of companies, for which it was assumed that the dividend statistically did not change, was calculated. The stock valuation according to Gordon's model was compared with the market price of the stock as of 29.12.2023, and then buy or sell signals were evaluated based on verification on 28.06.2024 – Table 6.

Table 6.
Stock valuation according to Gordon's model and verification of the forecast for companies in the WIG and S&P500 indices meeting the H_0 hypothesis

Index	Company symbol	Stock valuation according to the Gordon-Shapiro model as of 29.12.2023 [in PLN/$] for the 2023 dividend assuming:		Stock market closing price on 29.12.2023 [in PLN/$]	Buy [K]/ Sell [S] signal as of 29.12.2023		Forecast verification - stock market closing price [in PLN/$] on 28.06.2024
		10-year Treasury bonds + premium r_{PL}=7.98%; r_{US}=4.17% [1]	*S&P500 index + premium* $r_{gS\&P500}$=11.19% [2]		[1]	[2]	
WIG	BHW	112.78	-	101.40	K	-	97.80
	PZU	30.08	-	47.27	S	-	51.54
S&P500	GE	5.76	2.14	101.86	S	S	158.97
	INTC	17.75	6.61	50.25	S	S	30.97

Source: Own study.

Table 6 shows that PZU, GE and INTC were overvalued, regardless of the investor's assumed expected rate of return, while BHW was undervalued. The valuation of GE stocks at the levels of $5.76 [1] or $2.14 [2] with a market price of $101.86 as of 29.12.2023 looks the least likely. Moreover, the analysis showed that 2 out of 5 generated sell signals (which is 33.33%) were correct, which means that the investor would not suffer a loss. In contrast, the other 3 signals were wrong and the investor would not have made a profit.

5. Discussion and conclusions

The obtained results of the research on the comparison of Polish and American dividend companies confirm the existing practices of the latter in terms of the stability of dividend payments and the number of companies systematically transferring profits to stockholders. The largest companies, that are components of the WIG index, do not show as much concentration of dividend payment systematics as the companies in the S&P500 index, which were characterized by a lower diversity of dividend breaks between 2017 and 2023. The considerations presented and the research performed also made it possible to conclude, that Polish dividend companies, if they actually paid dividends characterized by higher dynamics of change, were, at the same time, burdened with higher variability of payments.

On the other hand, studies of stock valuation using the classical form of the Gordon-Shapiro model in the Polish and U.S. markets have shown shortcomings regarding the model's overly demanding assumptions, which are difficult for dividend companies to meet in practice. Accordingly, for no company in the Polish market was it possible to value stock according to the constant dividend growth rate model. Companies from the U.S. stock market performed much better, although it was possible to make a practical valuation for only 9 of the 24 companies, with only 2 companies having a fixed dividend growth rate, and 7 estimated as an average growth rate from 2017-2023. Unfortunately, the discrepancies that occurred between the model valuation of stocks and their stock market prices were significant, suggesting the impossibility of correctly valuing stocks in practice using the classical form of the Gordon-Shapiro model in the U.S. market as well.

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

H_1: The average rate of change in dividends paid by dividend companies included in the WIG index is actually higher than the average rate of change in dividends paid by issuers that are components of the S&P500 index.

H_2: The standard deviation of the rate of change of dividends is significantly lower for U.S. dividend companies than for dividend companies in the WIG index.

H_3: The use of the classical form of the Gordon-Shapiro model for stock valuation actually in practice does not allow for a reliable assessment and proper selection of listed companies for an investment portfolio in both the Polish and U.S. markets.

However, it should be noted, that there is a certain insufficiency in the research conducted regarding the set of dividend companies analyzed (especially for companies in the WIG index) and the time range of the analyses. The authors intend to conduct extended analyses of the issues raised in the article in the future with a more extensive dataset. It is also worth pointing out that, given the capitalization of the companies under research, the conclusions presented can be important recommendations for investors regarding the choice of companies, as well as the markets, on which they are listed.

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PREFERENCES OF POLISH CONSUMERS IN FRUIT CONSUMPTION AS A FACTOR IN THE ORGANIZATION OF THE MARKET FOR THESE PRODUCTS

Ksenia JUSZCZAK-SZELĄGOWSKA[1*], Weronika CZERWIŃSKA[2], Dawid OLEWNICKI[3], Krzysztof ZMARLICKI[4], Bożena NOSECKA[5]

[1] Department of Pomology and Horticultural Economics, Institute of Horticultural Sciences, Warsaw University of Life Sciences, Warsaw; ksenia_juszczak@sggw.edu.pl, ORCID: 0000-0001-8929-883
[2] Department of Economics of Agricultural and Horticultural Holdings, Institute of Agricultural and Food Economics - National Research Institute, Warsaw; weronika.czerwinska@ierigz.waw.pl, ORCID: 0009-0006-2087-9384
[3] Department of Pomology and Horticultural Economics, Institute of Horticultural Sciences, Warsaw University of Life Sciences, Warsaw; dawid_olewnicki@sggw.edu.pl, ORCID: 0000-0002-3096-3882
[4] Department of Scientific Planning and Multiannual Program, Research Institute of Horticulture, Skierniewice; krzysztof.zmarlicki@inhort.pl, ORCID: 0000-0002-1816-7592
[5] Department of Economics of Agricultural and Horticultural Holdings, Institute of Agricultural and Food Economics - National Research Institute, Warsaw; bozena.nosecka@ierigz.waw.pl, ORCID: 0000-0002-6285-0065
* Correspondence author

Purpose: The purpose of the survey was to assess consumer demand for fruit, as well as to evaluate the factors influencing that demand.
Methodology: In the study, as a background for the study of consumer preferences, the results of macroeconomic analyses were presented on changes in the consumption of fresh as well as processed fruits, broken down by their individual categories, in Poland over the years 2015-2022, by Central Statistical Office.The main part of the paper consists of analyses of primary data from surveys conducted using the CAWI method, on a group of 255 respondents, throughout Poland, in 2023. Analyses were performed using Statgraphics plus 4.1. Due to the lack of normal distribution and unequal groups, the significance of differences was tested using non-parametric Mann-Whitney U statistical tests for two grouping variables and Kruskal-Wallis ANOVA test for questions where there were more than three grouping variables. A significance level of $\alpha = 0.05$ was used in the analyses.
Findings: In the last years, Poles began to appreciate fruits health-promoting properties more. In addition, as a result of changes in consumer preferences and tastes, looking for more and more new flavors and preferring healthy lifestyles, it is difficult to expect a significant decline in the consumption of fruits in general, even with an increase in their prices, which, in the context of the current organization of the market, is a positive development.
Originality/value: The article shows current trends in fruit consumption in Poland. It also presents guidelines for further organization of the fruit market, as well as policies for shaping correct attitudes about fruit consumption.
Keywords: fruit, consumer preferences, consumption.
Category of the paper: research paper.

1. Introduction

Fruit production plays an important role in Polish agriculture. With its volume at 5.4 million tons in 2022, our country is among the largest producers of this assortment in the European Union. Also noteworthy is the fact that with apple production at 3-4 million tons, Poland is the largest producer of apples in the European Union, and the third largest producer in the world, just behind China and the US (FAO, 2024). Similar results are achieved in the production of raspberries, cherries, currants and blueberries, although their volume is much lower than apples, establishing our country as a significant producer on world markets. It should be added that the production of this assortment has a major impact on the food market, and thus on the formation of prices and demand for fruit.

Despite such a large scale in the production of many fruits, however, household surveys published by the Central Statistical Office show that the consumption of fruits in Poland, especially fresh ones, has been at a low level for many years, and is further declining, especially domestic ones. Taking into account the still lower level of consumption of fruits, but also vegetables in Poland in relation to the recommendations of the World Health Organization (WHO), it therefore becomes important to study the reasons for this decline, in order to create the basis for proper organization of the market, but also for the promotion of their consumption which aims to increase consumer interest in these products. Therefore, based on macroeconomic analysis and survey research, the purpose of the study was to assess the demand for fruits among consumers. Identification of factors influencing consumers' purchase preferences was carried out, such as frequency of purchase and consumption, choice of place of purchase, factors influencing purchase decisions, level of spending on fruits and vegetables and changes in consumption with respect to the previous year, among others. Changes in fruit consumption in Poland based on data from the Central Statistical Office (CSO) were shown as a background to the study.The literature shows that consumption and consumer behavior are determined by a number of factors, both consumer-dependent and environment-related. Internal factors include disposable income, owned assets and savings, labor force participation, as well as the previous level and structure of consumption. External factors, on the other hand, include the country's socio-economic situation and the influence of the international environment (Sobczyk, 2018). Hence, it should be added that the events that were observed in part during the years under analysis, such as the Sars-Cov 2 virus pandemic and the outbreak of armed conflict in Ukraine, had a huge economic impact. In addition, the increase in prices of goods and services, entailed an increase in inflation from 3.2% in 2021 to 17.5% in 2022 (Żurek, 2023). Problems with product availability also became apparent, all of which could affect consumers' purchasing decisions.

2. Factors shaping demand and the role of fruits and vegetables in the human diet

Food supply and demand are the main factors that affect the operation of the market mechanism, with prices playing an important role in the formation of these two factors. Price is a fundamental element of any offer and is a key factor that influences consumers' purchasing decisions. Its importance and the ability to effectively manage this marketing tool becomes increasingly important, especially in crisis situations (Waniowski, 2021). This was evident in 2021, when, as a result of the pandemic and warfare in Ukraine, the rise in food prices contributed to a sharp increase in inflation, although according to a survey conducted by Sekścińska (2022) on a group of consumers aged 18-81, it appears that inflation contributed very little to the reduction in food spending in Poland. Nearly half of those surveyed have not changed their eating habits. In contrast, only 1% of respondents have definitely reduced their food spending.

Fruits as well as vegetables are the foundation of the Food Pyramid, which emphasizes their key role in the human diet. Health organizations recommend diets based on their regular consumption (Bieniek-Majka, 2022). Many scientific studies point to the effects of a shortage of fruits and vegetables in the diet and the increasing incidence of chronic non-communicable diseases. According to the WHO, malignant tumors are the most common cause of death worldwide, causing more than 8 million deaths annually. Dietary factors are estimated to be responsible for about 30% of cancer cases in industrialized countries. An adequate diet is the second most important factor, after avoiding smoking, in reducing cancer risk. Regular physical activity, combined with a balanced diet based mainly on fruits and vegetables, is crucial for the optimal development and health of children and adolescents. Fruits and vegetables provide a variety of nutrients, such as vitamin C, pro-vitamin A, zinc, selenium and potassium, which play an important role in neutralizing free radicals in the body. In addition, the method of preparation and heat treatment affect the mineral and nutrient content of these products (Oleśków, 2017; Doniec et al., 2020). One of the key factors influencing the consumption of fruits and vegetables is their quality. The quality of food products is most often defined by their characteristics. According to one of the most well-known and frequently quoted definitions, food quality includes the degree of health safety, sensory appeal and availability from the perspective of the consumer and society, taking into account the constraints of raw materials, technology and price provided for these products (Kijowski, Sikora, 2003). According to the recommendations of the World Health Organization (WHO), daily consumption of an adequate amount of fruits and vegetables is an essential part of a healthy diet. According to the latest WHO position for adults, it is recommended to consume about 400 g of fruits and vegetables in five servings per day (Devirgiliis et al., 2024). According to Eurostat (2019), it appears that one in three EU citizens do not consume any fruits and vegetables during the day. Research by

Freshfel Europe (2021), as well as Goryńska-Goldmann (2024), shows that in 2021, the daily consumption of fruits and vegetables in EU countries was 365 grams per person. Which indicated that the level of fruit and vegetable consumption in all EU-27 countries, however, corresponded to WHO dietary recommendations. Moreover, according to the data, Poles were the few who met the WHO recommendations. It should be added that the above study was carried out on the basis of FAO balance sheet data, which differ significantly from the data from the CSO's survey of household budgets. Thus, in Poland, the average annual consumption of fruits and vegetables in 2019-2021 per capita according to the balance sheet data was 180.9 kg (Goryńska-Goldmann, 2024), while the survey of household budgets shows that the Polish consumer on average annually consumes a total of 102.3 kg of fruits and in vegetables (own calculations based on CSO, 2023). The amount of fruit and vegetable consumption depends on gender. Women were more likely than men to declare that they eat fruit at least once a day. Women consume more fruits and vegetables than men, which may be related to greater knowledge about healthy eating. Men are less aware of dietary recommendations and the risks associated with unhealthy habits, while women are more likely to link a healthy diet with a higher intake of fruits and vegetables (Bieniek-Majka, 2022).

According to Goryńska-Goldman (2024), Polish society, in terms of the amount of fruit and vegetable consumption on a macroeconomic scale, was most similar to many societies in Central Europe (i.e., Latvia, the Czech Republic, Lithuania, Hungary, Slovakia and Bulgaria), as well as to that of Cyprus. Poland ranked 38th as a fruit producer in the world in 2022, while in terms of vegetables it ranked 27th (Hałasiewicz et al., 2023). According to the Institute of Agricultural and Food Economics, there was a negative trade balance for both fruits and vegetables in 2022. This meant that more of these products were imported to Poland than were exported to other countries (Nosecka, 2023). This also demonstrates the changes taking place in the structure of fruit and vegetable consumption, which is the result of changing consumer preferences, seeking more and more new products and flavors.

3. Material and methods

In the study, as a background for the study of consumer preferences, the results of macroeconomic analyses were presented on changes in the consumption of fresh as well as processed fruits, broken down by their individual categories, in Poland over the years 2015-2022. The primary source of information for macroeconomic analyses was data from the survey of household budgets, conducted by the Central Statistical Office. The year 2015 was taken as 100%, from which the basic statistical parameters giving a summary description of the analyzed phenomenon were calculated, including fixed-base indices, with the help of which changes in the size of absolute data in the last analyzed year in relation to the base year were analyzed.

By calculating chain indices (with a variable base), the average annual rate of the changes under study was determined, the measure of which in the period under study (t0, t1) was the difference between the average chain index of the period and unity (Górczyński, 2004). The coefficients of variation, which are the quotient of the standard deviation and the arithmetic mean of the values studied, were also calculated.

The main part of the paper consists of analyses of primary data from surveys conducted using the CAWI method, on a group of 255 respondents, throughout Poland, in 2023. Women accounted for the largest share of the surveyed population, i.e. 60.0% of the total, taking part in the research. Men, on the other hand, accounted for 40.0%. The survey also established four age groups of respondents, i.e. 18-30 years old, 31-45 years old, 46-60 years old and over 60 years old. The largest group, 116 people (45.5%), were respondents aged 18-30. The percentage of respondents aged 31-45 was 30.2%, while those aged 46-60 and over 60 were 15.7% and 8.6%, respectively. Another factor characterizing the survey population was the place of residence. The largest group of study participants were residents of cities with a population of less than 50,000 (30.2%). The second smaller group among the survey participants were residents of cities with more than 250,000 residents accounting for 27.5%. The share of rural residents was 26.7%, while the smallest group, only 5.9% of people, lived in a city of 52 to 99.9 thousand residents.

Taking into account the monthly disposable income per person in the household, the largest number, 44.7%, of respondents had incomes above PLN 3000. The second largest group, in terms of numbers, were respondents with income between 2001 and 3000 PLN. The least numerous group of respondents (6.3%) were those with per capita incomes of up to PLN 1000.

This division made it possible to assess the diversity of respondents' opinions depending on selected factors. In this case, it was investigated whether there were statistically significant differences between selected factors, including the size of consumption or feelings about the increase in the price of fruit, and factors characterizing the respondents. Analyses were performed using Statgraphics plus 4.1. Due to the lack of normal distribution and unequal groups, the significance of differences was tested using non-parametric Mann-Whitney U statistical tests for two grouping variables and Kruskal-Wallis ANOVA test for questions where there were more than three grouping variables. A significance level of $\alpha = 0.05$ was used in the analyses.

4. Analysis of fruit consumption based on CSO data

The analysis carried out showed that the per capita consumption of fruit and preserves in total in Poland, in households, throughout the whole of the analyzed multi-year period increased on average annually by only 0.4% kg/person and was at the level of 44.4 kg/person in 2022, which means that it was only 3.1% higher than in 2015 (Table 1). It is noteworthy that in the case of fresh and chilled fruits, consumption in 2022 was at the same level as in the first year of the analyzed period. Over the entire multi-year period under study, the highest decrease in consumption (by 3.3% on average from year to year) was recorded for apples, and this was a total decrease of 20.9% from 13.2 kg/person in 2015 to 10.4 kg/person in 2022. Also, a negative rate of change was recorded in the consumption of stone fruits and berries, which averaged 2.5% and 1.3% annually. As a result, stone fruit consumption was 16.2% lower in 2022 than in 2015, while berry fruit consumption was 8.5% lower. Of the group of fresh and refrigerated fruits, the highest average annual rates of change of 4.4% and 4.3% were recorded for the consumption of bananas and the group of other fruits, respectively. Thus, in 2022. Poles consumed 35.3% more bananas on average than in 2015. Noteworthy is the increase in the consumption of other southern fruits, including a 9.2% increase in citrus fruits in the last year of analysis compared to the base year. The highest, 13.3% and 10.4% average annual rates of change over the entire analysis period were recorded in the consumption of processed fruit and frozen fruit, respectively. Thus, the increase in consumption of fruit preparations, which include jams, mousses, purees, among others, was at 140% in 2022 compared to 2015. In turn, the consumption of frozen fruits doubled in the same period. It should be added that these were the groups of fruits with the highest coefficient of variation, which for frozen fruits was at 37.6%, while for fruit preparations it reached 31.8%. In contrast, all other fruit groups analyzed recorded low variability, as evidenced by coefficient of variation values below 25%.

Table 1.
Fruit consumption in households in Poland in 2015-2022

Specification	2015		2016		2017		2018		2019		2020		2021		2022		Average annual rate of change	Coefficient of variation
	kg per person	%	kg per person	%	kg per person	%	kg per person	%	kg per person	%	kg per person	%	kg per person	%	kg per person	%		
Fruit and preserves	43,1	100,0	43,9	101,9	43,7	101,4	45,0	104,5	45,2	105,0	46,3	107,5	47,4	110,0	44,4	103,1	0,4	3,2
Fresh and chilled fruit	41,3	100,0	41,9	101,5	41,6	100,9	42,7	103,5	42,8	103,8	43,4	105,2	44,3	107,3	41,3	100,0	0,0	2,6
apples	13,2	100,0	13,0	98,2	12,0	90,9	11,6	88,2	12,1	91,8	11,3	85,5	11,2	84,5	10,4	79,1	-3,3	7,8
berries	5,6	100,0	5,2	91,5	4,9	87,2	5,0	89,4	4,8	85,1	5,0	89,4	5,2	91,5	5,2	91,5	-1,3	4,8
stone fruit	4,4	100,0	4,4	100,0	4,0	89,2	5,2	116,2	4,7	105,4	3,6	81,1	3,5	78,4	3,7	83,8	-2,5	14,1
citrus	7,8	100,0	8,2	104,6	8,0	103,1	8,0	103,1	8,5	109,2	8,8	112,3	9,4	120,0	8,5	109,2	1,3	6,0
bananas	6,1	100,0	6,8	111,8	7,9	129,4	7,8	127,5	7,8	127,5	9,4	152,9	9,1	149,0	8,3	135,3	4,4	13,6
others	3,8	100,0	4,3	112,5	4,8	125,0	5,0	131,3	4,9	128,1	5,4	140,6	6,0	156,3	5,2	134,4	4,3	13,3
Dried fruit and nuts	1,2	100,0	1,2	100,0	1,2	100,0	1,3	110,0	1,3	110,0	1,4	120,0	1,6	130,0	1,4	120,0	2,6	10,1
Frozen fruit	0,1	100,0	0,1	100,0	0,1	100,0	0,1	100,0	0,1	100,0	0,2	200,0	0,2	200,0	0,2	200,0	10,4	37,6
Fruit preparations	0,6	100,0	0,7	120,0	0,7	120,0	0,8	140,0	1,0	160,0	1,2	200,0	1,3	220,0	1,4	240,0	13,3	31,8
Fruit juices	9,6	100,0	9,5	99,0	9,7	101,3	10,0	103,8	10,6	110,0	11,4	118,8	11,9	123,8	11,5	120,0	2,6	9,1

Source: own analysis according to IERiGŻ PIB study based on CSO data.

5. Survey results

Grocery shopping, is one of the basic activities performed almost daily. It was therefore important to determine, the frequency of purchasing fruits during such activities. The survey showed that the vast majority of respondents purchased conventionally grown fruits very often and frequently. In the case of fruits, very frequent and frequent purchases were indicated by 42.0% and 46.3%, respectively. Respondents, on the other hand, rarely bought fruits labeled BIO, as indicated by 32.5% and 32.5% of respondents, respectively. It is worth noting that one-fifth of the survey participants did not purchase these products at all (Fig. 1). Also, a study conducted by Zmarlicki (2010) on a group of Skierniewice students shows that the willingness to purchase fruits, but also vegetables from organic farming more than a decade ago was also negligible. The implication is that despite the passage of years, consumer attitudes toward buying this type of food are still incidental. The most of respondents indicated that they would be able to purchase BIO fruits if their price was similar to conventionally grown products. Another issue of lack of interest in organic products indicated by the above author was their often unattractive appearance, which did not encourage consumers to purchase them.

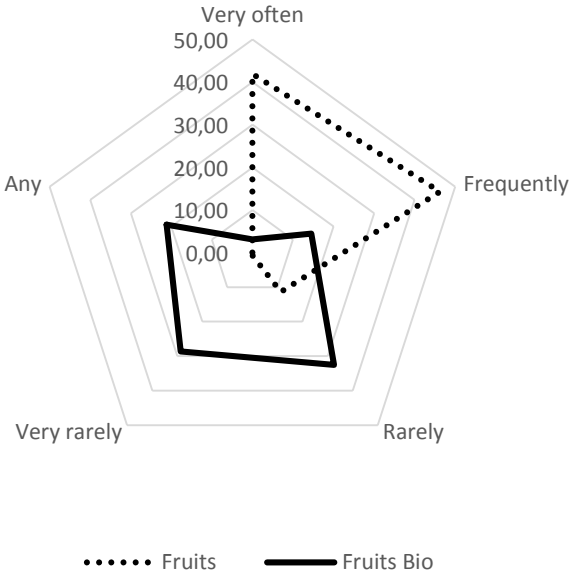

Figure 1. Frequency of fruit buying by respondents (in %).

Source: own research.

The analysis shows that the significant proportion of respondents consumed fruit daily, as indicated by 47.8% of respondents. Several times a week fruit was consumed by 37.6% of respondents, while only once a week fruit was consumed by 11.4% None of the respondents indicated that they consumed fruit less than once a month (Fig. 2).

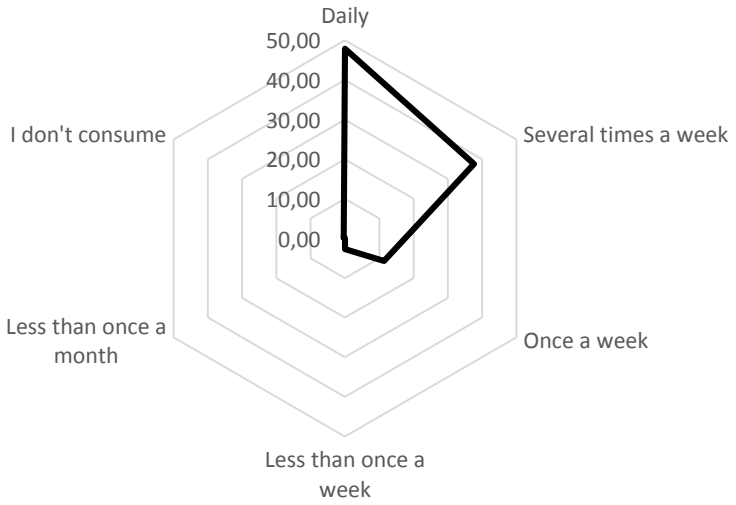

Figure 2. Frequency of fruit consumption according to respondents (in %).
Source: own research.

Among the most frequently purchased fruits were apples and bananas. Purchases of these fruits were indicated by 80.8 and 76.5%, respectively. Fruits such as cherries, grapes, oranges and pears were frequently purchased by 15.7 to 23.5% of respondents. Other frequently purchased fruits, whose purchases were indicated by a total of 75.3% of respondents, included kiwis, raspberries, tangerines, plums, strawberries, pineapples, avocados, blueberries, lemons, mangoes, peaches, grapefruits, cherries, watermelons, nectarines (Fig. 3). However, it should be pointed out that many of these species are seasonal fruits, which certainly translates into uneven consumption throughout the year. A study conducted by Ilow et al. (2011) also showed that apples and bananas were the most frequently consumed fruits among respondents.

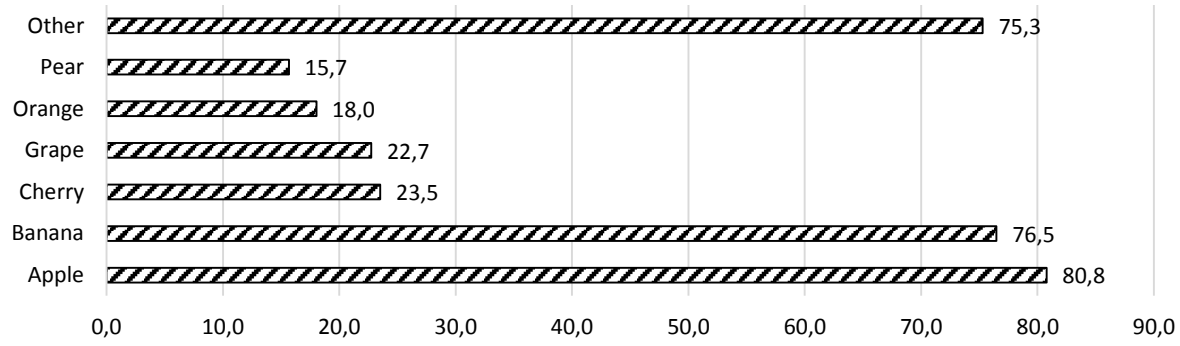

Figure 3. Most frequently purchased fruits in the opinion of respondents (in %).
Source: own research.

The analysis shows that the vast majority of respondents purchased fruit very often (42.4%) and often (35.3%) from large grocery stores, i.e. hypermarkets or discount stores. In contrast, respondents very rarely bought fruit in small grocery stores (31.4%) and from street sales (28.2%). It is worth noting that almost 1/3 of the respondents did not buy at these stores at all (Fig. 4). A study conducted by Czernyszewicz (2008) in Lublin shows that consumers more than 15 years ago most often purchased fruit at markets and fruit and vegetable stores, although, according to the author, this depended on particular groups of fruit and even species. In general, comparing the above results, it is reasonable to assume that the importance of these fruit distribution channels has clearly declined over this time.

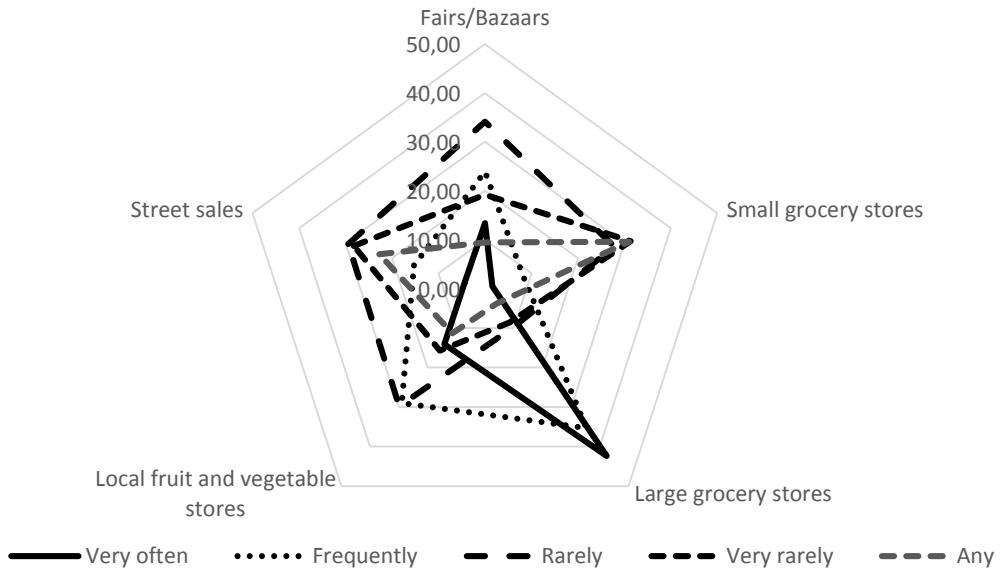

Figure 4. Frequency and place of fruit purchase by respondents (in %).
Source: own research.

When purchasing fruit, the most important factor was its freshness and quality, as indicated by 89.4 and 72.9% of respondents, respectively. Nutritional value and the species itself were also of great importance to respondents. It is worth pointing out that the brand/manufacturer of the fruit for 43.5% of the survey participants was indifferent (Figure 5). Similarly, a study conducted by Kierczyńska (2010) on a group of students at the University of Life Sciences in Poznań showed that taste was the most important factor in choosing fruit, followed by appearance and freshness, and then health values.

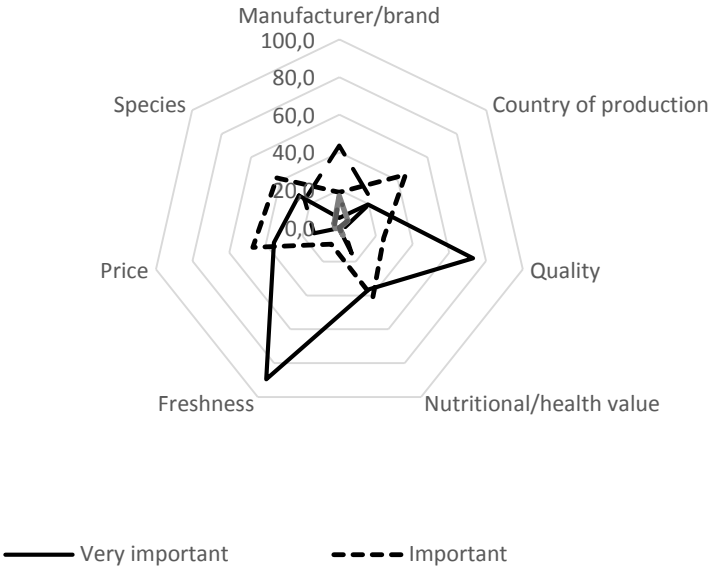

Figure 5. Factors influencing the purchase of fruit by respondents (in %).
Source: own research.

The survey showed that of all the factors determining the choice of where to buy fruit, the most important for respondents was the location near their place of residence, which was indicated by nearly 3/4 of the respondents. It is worth pointing out that this factor was more than 80% most often indicated by those over 60 years of age. It is also noteworthy that low prices at the point of sale ranked only fourth among the factors for choosing where to buy fruit, although it was indicated by more than 50% of respondents. More than 60% of respondents, when choosing where to buy, were guided by the high quality of the products and the wide assortment of sales. On the other hand, the cleanliness of the store, discounts offered, helpful staff and advertising were factors that influenced consumers' decisions on choosing a place to buy to a lesser extent (Fig. 6).

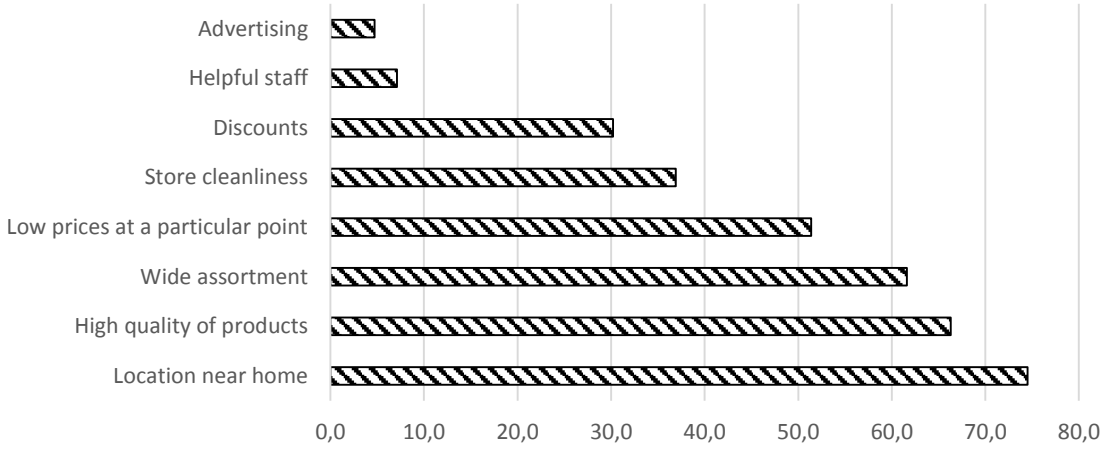

Figure 6. Factors influencing respondents' choice of where to buy fruit (in %).
Source: own research.

The survey shows that more than half, 58.4%, of the respondents consumed the same amount of fruit compared to the previous year. Noteworthy is the fact that despite the increase in inflation during the period under review, as well as the increase in prices, 22.4% of all respondents increased their fruit consumption compared to the previous year. Considering the gender of respondents, both 58.2% of women and 58.8% of men said they consumed the same amount of fruit (Table 2). In contrast, 22.9% of women and 21.6% of men, respectively, increased their consumption. It is interesting to note that considering age groups, the largest number of respondents within each group indicated that they bought the same amount of fruit compared to the previous year. However, taking into account the individual characteristics of respondents, it is worth noting that in the case of those aged 18-30, as many as 36.2% of them consumed more fruit compared to 2022. In the case of income groups and place of residence, there were no clear differences in attitudes towards fruit consumption. However, it is worth pointing out that 40.9% of students, as well as 66.4% of employees working in a company or office, 75.0% of people not working anywhere, and 80.0% of retirees consumed the same amount of fruit compared to the previous year. The analysis also shows that 48.7% of self-employed opinion leaders consumed the same amount of fruit, but 35.9% of people indicated that they consumed more fruit than in the previous year. A study conducted by Jąder (2016) shows that the highest fruit consumption was observed among pensioners and pensioners, as well as among those living in households with the highest income.

The statistical analyses conducted showed significant differences for the age of the respondents and for the socioeconomic situation and the amount of fruit consumption compared to the previous year, as indicated by the values of the Z statistic and the H of the Mann-Whitney U and Kruskal-Wallis ANOVA tests and p-values. The differences were that, younger people (18-30 years old) proportionally increased fruit consumption more than other people. Also, students and the self-employed increased their consumption than other respondents from other socioeconomic groups. The survey shows that more than half, 58.4%, of the respondents consumed the same amount of fruit compared to the previous year. Noteworthy is the fact that despite the increase in inflation during the period under review, as well as the increase in prices, 22.4% of all respondents increased their fruit consumption compared to the previous year. Considering the gender of respondents, both 58.2% of women and 58.8% of men said they consumed the same amount of fruit (Table 2). In contrast, 22.9% of women and 21.6% of men, respectively, increased their consumption. It is interesting to note that considering age groups, the largest number of respondents within each group indicated that they bought the same amount of fruit compared to the previous year. However, taking into account the individual characteristics of respondents, it is worth noting that in the case of those aged 18-30, as many as 36.2% of them consumed more fruit compared to 2022. In the case of income groups and place of residence, there were no clear differences in attitudes towards fruit consumption. However, it is worth pointing out that 40.9% of students, as well as 66.4% of employees working in a company or office, 75.0% of people not working anywhere,

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Table 2.
Amount of fruit consumed by respondents compared to the previous year (in %)

Specification		Respondents' indications (in %)			Number n	Value of statistics	
		More	Less	Same		p-value	Z or H*
Overall		26,7	14,9	58,4	255		
Gender	F	26,1	15,7	58,2	153	0,8536	-0,1846
	M	27,5	13,7	58,8	102		
Age	18-30 years	36,2	15,5	48,3	116	**0,0447**	8,0642
	31-45 years	20,8	13,0	66,2	77		
	46-60 years	17,5	20,0	62,5	40		
	Over 60 years	13,6	9,1	77,3	22		
Education	Average	24,2	15,4	60,4	91	0,8250	0,9017
	Vocational	37,5	12,5	50,0	8		
	Higher	27,7	14,8	57,4	155		
Residence	Village	29,4	8,8	61,8	68	0,5462	3,0700
	Town up to a 50 t. inhabitants	26,0	13,0	61,0	77		
	Town from 51 to 99 t. inhabitants	26,7	13,3	60,0	15		
	Town from 100 to 250 t. inhabitants	20,0	20,0	60,0	25		
	Town over 250 t. inhabitants	27,1	21,4	51,4	70		
Monthly disposable income	Up to a 1000 zł	18,8	12,5	68,8	16	0,5694	2,0145
	1001-2000 zł	28,6	18,4	53,1	49		
	2001-3000 zł	32,9	13,2	53,9	76		
	Over 3000 zł	22,8	14,9	62,3	114		
Socio-economic situation	Student	40,9	18,2	40,9	66	**0,0070**	14,0929
	Self-employed	35,9	15,4	48,7	39		
	Company/office employee	19,7	13,9	66,4	122		
	Pensioner	10,0	10,0	80,0	20		
	Currently not working anywhere	12,5	12,5	75,0	8		

* Z for Mann-Whitney U, H for Kruskal-Wallis.

Sources: Own research.

Based on the analysis, it can be indicated that as many as 73.3% of all respondents allocate a greater amount of cash for fruit purchases compared to the previous year. Taking into account the gender of the respondents, the most of women (76.5%) as well as men (68.6%) said that they allocate a greater amount of cash compared to the previous year (Table 3). It is interesting to note that considering age groups, each of them allocated more cash for fruit purchases. In the case of income groups, place of residence, monthly disposable income and socioeconomic situation, no clear differences were observed in the allocation of cash for fruit. Each of these groups allocated more of them compared to the previous year.

The statistical analyses conducted showed significant differences for respondents' education, socioeconomic situation and monthly disposable income per person in the household and the amount of cash allocated for fruit compared to 2022, as indicated by the values of the Z statistic and the H of the Mann-Whitney U and Kruskal-Wallis ANOVA tests and p-values. The differences are that those with vocational and secondary education spent less or the same amount of money in the past year, while the significant proportion of those with higher education, spent more money on fruit purchases compared to the previous year. In the case of monthly income, those in the income group from PLN 1001 to 2000 stood out from the other income groups in that, the vast majority of them (85.7%) allocated more cash for fruit purchases compared to the previous year, while the same amount of cash was allocated by only 2.0% of respondents in this group. Also, 80.0% of retirees stood out in that they allocated more cash for fruit purchases compared to the previous year, while only 5.0% of respondents in this group allocated less.

Table 3.
Amount of money spent on fruit purchases by respondents compared to the previous year (in %)

Specification		**Respondents' indications (in %)**			Number n	**Value of statistics**	
		More	Less	Same		p-value	Z or H*
Overall		73,3	7,8	18,8	255		
Gender	K	76,5	7,8	15,7	153	0,3288	-0,9766
	M	68,6	7,8	23,5	102		
Age	18-30 years	72,4	9,5	18,1	116	0,6428	1,6738
	31-45 years	75,3	7,8	16,9	77		
	46-60 years	70,0	5,0	25,0	40		
	Pow. 60 years	77,3	4,5	18,2	22		
Education	Average	65,9	5,5	28,6	91	**0,0048**	12,9292
	Vocational	62,5	25,0	12,5	8		
	Higher	78,7	8,4	12,9	155		
	Village	72,1	2,9	25,0	68		
Residence	Town up to a 50 t. inhabitants	74,0	6,5	19,5	77	0,1824	6,2333
	Town from 51 to 99 t. inhabitants	80,0	6,7	13,3	15		
	Town from 100 to 250 t. inhabitants	68,0	16,0	16,0	25		
	Town over 250 t. inhabitants	74,3	11,4	14,3	70		

Cont. table 3.

Monthly disposable income	Up to a 1000 zł	68,8	6,3	25,0	16	**0,0042**	13,2248
	1001-2000 zł	85,7	12,2	2,0	49		
	2001-3000 zł	67,1	5,3	27,6	76		
	Over 3000 zł	72,8	7,9	19,3	114		
Socio-economic situation	Student	72,7	13,6	13,6	66	**0,0109**	13,0734
	Self-employed	69,2	5,1	25,6	39		
	Company/office employee	76,2	6,6	17,2	122		
	Pensioner	80,0	5,0	15,0	20		
	Currently not working anywhere	37,5	0,0	62,5	8		

* Z for Mann-Whitney U, H for Kruskal-Wallis.

Sources: Own research.

Based on the analysis, it can be indicated that 46.7% of all respondents felt the increase in fruit prices very strongly compared to the previous year. Considering gender, 57.5% of women felt the price increase very strongly and 51.0% of men felt the price increase only strongly (Table 4). It is interesting to note that considering age groups, more than 80.0% of respondents from all groups felt very strongly or strongly about the increase in fruit prices compared to 2022. Similarly, that is, the vast majority of survey participants felt very strongly or strongly about the increase in fruit prices regardless of their place of residence, monthly disposable income and even socioeconomic situation.

Statistically significant differences existed, among others, in the case of gender and feeling the increase in fruit prices compared to the previous year. Women were significantly more strongly affected by the increase in fruit prices than men. This confirms a study by Suliga (2012), which found that women over the age of 30 consume fruit significantly more often than men. It is worth pointing out that the group of women in the present study accounted for more than 60% of the respondents.

Table 4.
Respondents' feelings caused by the increase in fruit prices compared to the previous year (in %)

Specification		**Respondents' indications (in %)**				Number n	**Value of statistics**	
		I feel very strongly	I feel strongly	I feel slightly	I don't feel		p-value	Z or H*
Overall		46,7	38,0	13,3	2,0	255		
Gender	K	57,5	29,4	11,1	2,0	153	**0,0435**	-2,0191
	M	30,4	51,0	16,7	2,0	102		
Age	18-30 years	41,4	40,5	15,5	2,6	116	0,8242	0,9053
	31-45 years	55,8	33,8	9,1	1,3	77		
	46-60 years	52,5	32,5	12,5	2,5	40		
	Over 60 years	31,8	50,0	18,2	0,0	22		
Education	Average	44,0	37,4	17,6	1,1	91	0,6028	1,8561
	Vocational	25,0	62,5	12,5	0,0	8		
	Higher	49,0	37,4	11,0	2,6	155		
	Village	42,6	45,6	10,3	1,5	68		

Cont. table 4.

Residence	Town up to a 50 t. inhabitants	49,4	31,2	16,9	2,6	77	0,2008	5,9782
	Town from 51 to 99 t. inhabitants	40,0	46,7	13,3	0,0	15		
	Town from 100 to 250 t. inhabitants	68,0	20,0	12,0	0,0	25		
	Town over 250 t. inhabitants	41,4	42,9	12,9	2,9	70		
Monthly disposable income	Up to a 1000 zł	62,5	31,3	6,3	0,0	16	0,0519	7,7330
	1001-2000 zł	51,0	44,9	4,1	0,0	49		
	2001-3000 zł	40,8	44,7	13,2	1,3	76		
	Over 3000 zł	46,5	31,6	18,4	3,5	114		
Socio-economic situation	Student	34,8	50,0	15,2	0,0	66	0,1515	6,7190
	Self-employed	46,2	28,2	23,1	2,6	39		
	Company/office employee	54,9	32,8	9,0	3,3	122		
	Pensioner	35,0	50,0	15,0	0,0	20		
	Currently not working anywhere	50,0	37,5	12,5	0,0	8		

* Z for Mann-Whitney U, H for Kruskal-Wallis.

Sources: Own research.

The above survey results are confirmed by a report by the Center for Public Opinion Research (CBOS) published in 2023, according to which Poles have been greatly affected by inflation. The most disruptive was the increase in food prices. According to the research published in this report, respondents reduced their daily purchases and used substitutes.

6. Summary and conclusions

The analysis shows that fruit consumption showed an upward trend from 2015 to 2022, but it was a small increase, averaging 0.4% per year. The highest growth rate was recorded for frozen fruit, processed fruit and citrus fruit bananas and the group of other fruits. In contrast, the largest decrease in consumption was in apples, berries and stone fruits.

The results presented in the survey allow us to conclude that almost half of the surveyed consumers consume fruit on a daily basis. The most frequently consumed fruits are apples and bananas, whose consumption was indicated by 80.8% and 76.5% of surveyed consumers, respectively. In addition, the survey showed that most respondents purchase fruit very often. Purchases are mainly made at hypermarkets and discount grocery stores. Slightly less important are markets and local vegetable stores. In addition, the most important factor in respondents' choice of where to buy fruits and vegetables is the location close to where they live, which was indicated by more than 70% of respondents. A significant proportion of respondents choose places that offer a wide assortment and high quality produce. When shopping, respondents pay attention primarily to the freshness and quality of fruits.

Based on the analysis, it can be indicated that 46.7% of all respondents felt very strongly about the increase in the price of fruits, compared to the previous year, i.e. 2022. And although as many as 73.3% of all respondents spent more money on fruit purchases, compared to the previous year, this was not reflected in an increase in the consumption of these products. Thus, the survey showed that more than half, 58.4%, of respondents in 2023 consumed the same amount of fruit compared to the previous year, indicating that the amount of fruit consumed is due to certain eating habits. The price increase did not significantly decrease fruit consumption. Instead, consumers may have opted for lower-quality or substitute products. In addition, it is noteworthy that despite the increase in inflation during the period under review, as well as the increase in prices, as many as 22.4% of the total respondents increased their fruit consumption compared to the previous year. It is worth adding, as the literature shows, that during the pandemic period there was a very strong increase in fruit consumption, but also in vegetable consumption. This is due to the fact that in the face of massive COVID cases, taking care of their health, Poles began to appreciate their health-promoting properties more. In addition, as a result of changes in consumer preferences and tastes, looking for more and more new flavors and preferring healthy lifestyles, it is difficult to expect a significant decline in the consumption of fruits and vegetables in general, even with an increase in their prices, which, in the context of the current organization of the market, is a positive development.

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ORGANIZATION AND MANAGEMENT SERIES NO. 215

THE ROLE OF WORK-LIFE-BALANCE IN EFFECTIVE BUSINESS MANAGEMENT

Anna KASPERCZUK[1], Michał ĆWIĄKAŁA[2], Ernest GÓRKA[3], Piotr RĘCZAJSKI[4], Piotr MRZYGŁÓD[5], Maciej FRASUNKIEWICZ[6], Agnieszka DARCIŃSKA-GŁĘBOCKA[7], Jan PIWNIK[8], Grzegorz GARDOCKI[9]

[1] Bialystok University of Technology, Faculty of Mechanical Engineering; a.kasperczuk@pb.edu.pl, ORCID: 0000-0002-5919-5346
[2] I'M Brand Institute sp. z o.o.; m.cwiakala@imbrandinstitute.pl, ORCID: 0000-0001-9706-864X
[3] WSB - National-Louis University, Faculty of Social Sciences and Computer Science; ewgorka@wsb-nlu.edu.pl, ORCID: 0009-0006-3293-5670
[4] MAMASTUDIO Pawlik, Ręczajski, spółka jawna; piotr@mamastudio.pl, ORCID: 0009-0000-4745-5940
[5] Piotr Mrzygłód Sprzedaż-Marketing-Consulting; piotr@marketing-sprzedaz.pl, ORCID: 0009-0006-5269-0359
[6] F3-TFS sp. z o.o.; m.frasunkiewicz@imbrandinstitute.pl, ORCID: 0009-0006-6079-4924
[7] Bialystok University of Technology, Faculty of Mechanical Engineering; a.dardzinska@pb.edu.pl, ORCID: 0000-0002-2811-0274
[8] WSB Merito University in Gdańsk, Faculty of Computer Science and New Technologies; jpiwnik@wsb.gda.pl, ORCID: 0000-0001-9436-7142
[9] ZS "Strzelec" OSW JS 1011 Grajewo; g.gardocki@wp.pl, ORCID: 0009-0000-0220-2181
* Correspondence author

Purpose: This paper explores the role of work-life balance (WLB) in enhancing employee motivation. It also examines how balancing professional and personal life impacts business management.
Design/methodology/approach: The research used a quantitative methodology and an online survey of 102 individuals. It focused on flexible working hours, private medical care, and company cars.
Findings: Flexible working hours were the most effective tool for improving WLB. A positive correlation was found between WLB perception and employee motivation.
Research limitations/implications: The study is limited to a specific demographic and geographic scope. Future research could explore diverse cultural and occupational contexts.
Practical implications: Flexible working hours and private medical care significantly enhance employee satisfaction. These strategies also strengthen employer branding and reduce turnover.
Social implications: Promoting WLB can reduce stress and improve societal well-being. Organisations adopting WLB strategies set benchmarks for corporate social responsibility.
Originality/value: This study evaluates WLB tools and their impact on employee motivation. It provides valuable insights for HR managers and organisational leaders.
Keywords: management, work-life balance, boundary theory, motivation.
Category of the paper: research paper.

1. Introduction

In an era of rapid technological development, globalisation of markets and increasing competition, the importance of work-life balance is growing and becoming an integral part of human resource management strategies in companies around the world. Today's labour market is characterised by dynamic change, with challenges for employees to adapt, time pressures and a constant need for upskilling. In the face of these challenges, work-life balance is no longer a luxury or an add-on to employee benefits, but is becoming a key tool to influence employee motivation, productivity and loyalty (Tomaszewska-Lipiec, 2014).

Professional work, despite its potential for development and the opportunity to realise professional ambitions, often leads to excessive strain, stress and a lack of work-life balance. The negative consequences of this, such as job burnout and a decline in productivity, are increasingly recognised by employers, who realise that satisfied and motivated employees are the key to an organisation's success (Currie, Eveline, 2011).

Today, work-life balance, often referred to as work-life harmony, has become a key area of research and human resource management practices. Despite the apparent simplicity of the concept, its complexity and multidimensionality make it challenging to fully understand and effectively implement in an organisational context (Sadowska-Snarska, 2013).

The modern approach to work-life balance is based on the belief that employees should be treated not only as a source of labour, but also as individuals with a life of their own outside the workplace. Therefore, the concept promotes the harmonious integration of work and personal responsibilities, aiming to provide individuals with satisfaction and fulfilment in both the professional and private spheres (Wierda et al., 2008).

The term ‘work-life balance’ (WLB) gained popularity in the 1970s in the United States, mainly as a response to the challenges of the traditional family model and the increasing labour force participation of women. In the following decade, the concept expanded to include any initiative to support employees in balancing their work and personal commitments, regardless of the family context. In practice, this means that work-life harmony is achieved when neither sphere dominates at the expense of the other (Wiradendi et al., 2021).

Research shows a variety of approaches to analysing the concept of work-life balance (WLB), focusing on work-life relationships. According to the literature, there are three main approaches to describing this relationship. The first approach suggests the independence of the two spheres, according to segmentation theory. The second approach describes unidirectional influences, where mainly work interacts with private life, as presented by spillover theory. The third approach refers to reciprocal influences, according to theories such as facilitation, enrichment, domino effect and compensation theory, which implies a certain compatibility between work and personal life (Menderak, 2019).

The relationship between the spheres of work and life is often described in different ways. Firstly, they can generate conflicting expectations. Secondly, they can be mutually beneficial, where resources and experiences from one sphere benefit the other. And finally, they can be complementary, where deficiencies in one sphere are compensated by the other (Wiradendi et al., 2021).

Research on WLB in Poland often mirrors research directions observed in other parts of the world and faces similar challenges. According to the findings of Stańczak and other researchers (2017), there are six key thematic areas specific to Polish WLB research:

1. Identification of the obstacles to achieving work-life balance and the associated need for support in developing a WLB strategy.
2. Analysis of companies' approaches to WLB and their proposed solutions.
3. Exploring the experiences of women who harmonise work life with family responsibilities.
4. Defining and varying interpretations of the concept of WLB.
5. Analysing awareness of the benefits of work-life balance.
6. Evaluating the implementation of WLB strategies in practice.

2. Motivation theories in the context of WLB

Boundary theory emphasises the existence of two separate but related spheres: work and personal life. Depending on their values, attitudes and thinking patterns, people manage these areas variously, aiming for a harmonious combination. Balance is about minimising conflict and functioning smoothly in both areas. These boundaries can take many forms: psychological (emotions, thoughts), physical (e.g. space) or temporal (e.g. working hours) (Karassvidou, Glaveli, 2015).

Contemporary research suggests that the strength of a boundary depends on its flexibility, permeability and ability to bridge different aspects of life. Boundary crossers play an important role in shaping the work-life dynamic. Not only are they participants, but they also shape the direction and rules of both, based on their influence and identity. In the Polish scientific literature, the analysis of work-life dynamics from the perspective of boundary theory is relatively rare. Only a few publications on work-life boundaries in the context of remote working have been noted so far. There is also research on the impact of mobile technologies on work-life interactions and on work-family dynamics (Kubacka, Mroczkowska, 2020).

The research model described allows the analysis of different aspects of work-life boundaries: physical, temporal and psychological. It focuses on key variables such as interpersonal relationships or subjective interpretations and valuations in the context of organisational factors such as working time policies. In addition, it emphasises the importance

of the psychological shaping and feeling of these boundaries to understand the subjective experience of balance (Kubacka, Mroczkowska, 2020).

3. Impact of work-life balance on commitment and job satisfaction

Maintaining a work-life balance has become an important issue in the context of quality of working life. This balance implies a smooth harmonisation of professional and personal responsibilities, which theoretically translates into improved well-being, satisfaction and efficiency at work. Being professionally active implies a deep commitment to the tasks at hand, a strong emotional bond with the organisation and a willingness to put in extra effort to achieve common goals. Research shows that employees who are able to achieve a better work-life balance tend to show greater commitment to their responsibilities. This balance also promotes better time allocation between work and private life, which reduces the risk of burnout and increases the willingness to engage with the company (Paszkiewicz, Wasiluk, 2022).

Job satisfaction is about positively evaluating one's own experiences and expectations of work. People who are able to manage their time effectively and find a work-life balance often experience higher job satisfaction. Maintaining a work-life balance can contribute to an improved sense of well-being, reduced stress levels and an increased sense of control over one's life, resulting in overall job satisfaction (Skrok et al., 2023).

For companies that care about the wellbeing of their employees, promoting work-life balance is becoming an important priority. Employees who value this balance are more loyal to their employer, less likely to change jobs and more likely to recommend it to others as an attractive place of employment. Moreover, high levels of engagement and job satisfaction translate into higher productivity, innovation and a favourable company image (Skrok et al., 2023).

4. Research material and method

The aim of this study was to analyse the role of work-life balance as an instrument influencing employee motivation in the context of the contemporary labour market. By exploring the mechanisms influencing work-life balance and identifying the benefits of maintaining it, an attempt was made to understand what strategies and actions can contribute to increasing employee satisfaction and commitment in the current work environment.

Research hypothesis: Organisations that actively support the work-life balance of their employees through various initiatives and programmes have more motivated employees compared to organisations that do not offer such support.

The following research questions were posed to complement the research hypothesis:

1. Are employees satisfied with their own level of work-life balance?
2. Which work-life balance instruments can be considered the most effective in the opinion of respondents?

The survey took place between May and July 2023, where the Internet was the main tool for data collection. The survey questionnaire was prepared using the Google Forms platform and made available through thematic forums and other online platforms. Participants were assured of the anonymity of their responses and the purpose of the survey was presented. In addition, participants were given the option to stop completing the questionnaire at any time.

The collected data were statistically analysed and presented in the form of tables and graphs. Frequency analysis and basic descriptive statistics for quantitative data, such as mean, median and standard deviation, were used to analyse the data. An analysis of variance (ANOVA) with repeated measures was performed to compare motivator ratings. Comparisons between two independent samples were made using the Student's t-test or the Mann-Whitney test when assumptions about the normality of the data distribution were not met. On the other hand, for comparison of values between more than two independent groups, analysis of variance (ANOVA) or the Kruskal-Wallis test was used. When significant differences were detected, POST-HOC tests were used for more detailed analysis. The normality of the data distribution was checked using the Shapiro-Wilk test. Analysis of the relationship between quantitative variables was performed using Pearson's or Spearman's correlation analysis. The significance level was taken at $\alpha = 0.05$. All analyses were performed using Statistica 13.3 software from StatSoft.

The survey involved 102 economically active people, of whom 61.76% were women and 38.24% were men. The age range of 18 to 25 years was 9.80% of the respondents, 26 to 35 years was 48.04% and 36 to 45 years was 29.41%. The remaining 12.75% were employees aged 46 and over. The largest age group in the study group was made up of respondents with a length of service of 11 to 15 years and 16 to 20 years.

5. Research results and discussion

An assessment of the level of work-life balance among the study participants was conducted. It was found that those surveyed generally expressed medium satisfaction with their work-life balance. This was indicated by 40.00% of respondents. However, only 6.67% of

respondents were very satisfied with this balance, while the remaining 6.67% of employees admitted that they were dissatisfied with their work-life balance.

Differences in the assessment of the level of work-life balance in the light of sociodemographic variables were analysed. The results are presented in Table 1. A slightly higher assessment of work-life balance was found among women (M = 3.49; SD = 0.78) compared to men (M = 3.33; SD = 0.66). However, the demonstrated differences in the level of work-life balance between men and women did not reach statistical significance (p > 0.05).

Table 1.
Self-assessment of work-life balance level by gender (N = 102)

Gender	Woman (n = 63)			Man (n = 39)			Significance
Self-assessment of Work-Life Balance	*M*	*Me*	*SD*	*M*	*Me*	*SD*	*p*
	3,49	3,00	0,78	3,33	3,00	0,66	0,511

M – Mean; Me – Median; SD – Standard Deviation; p – Probability Level.

Source: Own elaboration based on conducted research.

In contrast, statistically significant differences were observed between age groups with regard to the level of work-life balance (p = 0.005). The highest level of work-life balance was observed among the oldest age group (M = 4.00; SD = 0.71). In contrast, the lowest level of self-assessed balance was observed among those aged 36-45 years (M = 3.17; SD = 0.65) (Table 2).

Table 2.
Self-assessment of work-life balance level by age (N = 102)

Self-assessment of work-life balance level	*M*	*Me*	*SD*	*p*
18–25 years (n = 10)	3,70	4,00	0,48	0,005**
26–35 years (n = 49)	3,39	3,00	0,76	
36–45 years (n = 30)	3,17	3,00	0,65	
46 years and over (n = 13)	4,00	4,00	0,71	

** p < 0.01; M - mean; Me - median; SD - standard deviation; Z - test statistic; p - probability level.

Source: Own elaboration based on conducted research.

Respondents rated the effectiveness of selected instruments of the work-life balance concept on a scale of 1 to 5, where 1 meant ‘not important’, 2 - ‘not very important’, 3 - ‘moderately important’, 4 - ‘quite important’ and 5 - ‘very important’. The results of the analysis of variance are presented in Table 3. The analysis carried out showed statistically significant differences in the level of evaluation of the instruments of the concept used in the workplace (p < 0.001). Instruments such as the presence of animals in the workplace (M = 1.43; SD = 1.00) and interest circles (M = 1.85; SD = 1.18) received the lowest ratings. In contrast, flexible working hours (M = 4.39; SD = 1.06) appeared to be the highest rated instrument of the concept. Additionally, the highly rated instruments were private medical care and a company car also used for personal needs.

Table 3.
Evaluation of the effectiveness of selected instruments of the work-life balance concept (N = 102)

Instrument	*M*	*Me*	*Min*	*Max*	*SD*	*F*	*p*
Animals in the workplace[a]	1,43	1,00	1,00	5,00	1,00	10,98	<0,001***
Hobby groups[ab]	1,85	1,00	1,00	5,00	1,18		
Consultations with specialists on family and personal life [abc]	2,15	2,00	1,00	5,00	1,31		
Tuition reimbursement[abcd]	2,27	2,00	1,00	5,00	1,52		
Information on work-life balance [abcde]	2,32	2,00	1,00	5,00	1,52		
Company nursery [abcde]	2,37	2,00	1,00	5,00	1,56		
Study funding [bcde]	2,59	2,00	1,00	5,00	1,70		
Mortgage assistance [bcde]	2,69	3,00	1,00	5,00	1,43		
Family allowances [bcde]	2,87	2,00	1,00	5,00	1,56		
Telecommuting/remote working [bcdef]	2,95	3,00	1,00	5,00	1,60		
Transport to work [cdef]	3,09	3,00	1,00	5,00	1,66		
Language courses [cdef]	3,13	4,00	1,00	5,00	1,59		
Company events[cdef]	3,17	3,00	1,00	5,00	1,40		
MultiSport card [def]	3,33	3,00	1,00	5,00	1,49		
Catering [efg]	3,42	3,00	1,00	5,00	1,54		
Part-time work[efg]	3,45	4,00	1,00	5,00	1,53		
Private medical [fg]	3,81	4,00	1,00	5,00	1,24		
Company car for personal use [fg]	3,84	4,00	1,00	5,00	1,36		
Flexible working hours [g]	4,39	5,00	1,00	5,00	1,06		

[abc] successive letters stand for homogeneous groups; ***p < 0.001; M – mean; Me – median; SD – standard deviation; Min – minimum value; Max – maximum value; F – test statistic; p – probability level.

Source: Own elaboration based on conducted research.

The relationship between the assessment of the level of work-life balance behaviour and the perception of work motivation was analysed. The results of the analysis are presented in Table 4. A statistically significant positive correlation was found between self-assessment of the level of work-life balance and the level of work motivation (rho = 0.31; p = 0.002). The result obtained indicates that as the sense of work-life balance increases, the level of work motivation also increases.

Table 4.
Relationship between work-life balance assessment and work motivation level assessment – results of correlation analysis (N = 102)

Work-life-balance assessment	*rho*	*p*
Level of motivation	0,31**	0,002

** *p < 0,01; rho* – correlation coefficient; *p* – probability level.

Source: Own elaboration based on conducted research.

6. Summary

In today's fast-changing world, where the boundaries between work and personal life are becoming increasingly fluid, the concept of WLB is becoming extremely important for both employees and employers. Maintaining a healthy balance between these two spheres of life is crucial for an individual's wellbeing, job satisfaction and professional effectiveness. Consequently, a growing body of research is focusing on identifying the factors that influence WLB and the tools that can help improve it (Tomaszewska-Lipiec, 2014).

A study by Zheng and colleagues (2015) identified that work-life balance strategies and initiatives implemented in companies play a key role in supporting employees to achieve this balance. In addition to the programmes and initiatives offered, individual factors such as type of job, age, marital status and level of earnings influence the ability to balance work and personal life. It is therefore important to regularly monitor and adapt organisational WLB strategies and policies to better meet the individual needs of employees.

The results of the study showed that there is a slight but statistically significant difference in the assessment of WLB levels between men and women. There are several potential explanations for this phenomenon. Women may be more likely to express the need for work-life balance, which may be due to their traditional role in managing the home and caring for the family. On the other hand, men may experience more social pressure to devote more time and energy to work, which may affect their perception of their own balance (Krzykus, 2019).

The above results highlight the importance of understanding and supporting the needs of different age groups in the context of WLB. Organisations and HR decision-makers should take these differences into account when approaching policies and programmes that aim to support work-life balance.

The results of the survey, which identified flexible working hours as the highest-rated instrument in the WLB concept, reflect the growing need to adapt work schedules to the individual needs and wishes of employees. Flexible working hours enable employees to better adapt their working time to their private commitments and preferences, which can contribute to their satisfaction and commitment in the workplace. In addition, highly rated instruments such as private medical care or a company car also used for personal use emphasise the importance of employer support for aspects of life that go beyond the professional sphere (Krzykus, 2019).

The results indicate that companies are increasingly recognising and responding to employees' individual needs, offering solutions that support a harmonious work-life balance. This holistic and flexible model of approaching WLB can benefit both employees and organisations, contributing to increased productivity, employee retention and building a positive employer image.

Because of its ideological background, work-life balance (WLB) is seen as a value worthy of achievement. It is also a perceptual tool that shapes the way individuals interpret the surrounding reality, emphasising selected elements of it. The concept of WLB inspires individuals to maintain the belief that harmony can be achieved in life, and its ideological nature manifests itself in a dualistic conception of everyday life, understood as two separate domains (Ross i Vasantha, 2014).

The central idea of the WLB concept presented is to understand the ideological as well as the institutional, i.e. political, influence on the perception of work-life balance. It is these two spheres - work life and private life - that are the key areas that shape the daily choices of individuals and the relationships between them. With the concept of WLB, a clear division is made into two distinct spheres: work and private life. This classification not only makes it easier to analyse and understand individuals' daily activities, but also enables an in-depth understanding of how the two spheres interact. This division helps individuals identify areas in which they can strive to achieve harmony and balance (Skrok et al., 2023).

The introduction of the WLB concept is an important step in understanding the dynamics of work-life relationships. It provides a better understanding of how actions taken in one sphere of life can affect the other and what strategies can be adopted to make these relationships more harmonious. This concept provides a foundation for further research into work-life balance and for the development of organisational strategies and policies to support individuals in achieving this balance (Mroczkowska, Kubacka, 2020).

In conclusion, although most employees rate their work-life balance as average or satisfactory, there is a need to better understand the individual needs and expectations of employees in order to fully address the challenges of work-life harmony. Future research could also focus on the issue of work-life balance among the self-employed.

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DETERMINANTS OF DATA SECURITY OF THE ORDERING COMPANY DURING AN OUTSOURCING PROJECT

Damian KOCOT[1*], Bartosz BŁASZCZAK[2]

[1] University of Economics in Katowice; damian.kocot@ue.katowice.pl, ORCID: 0000-0001-9240-857X
[2] Higher School of Professional Education Wroclaw; bartosz.blaszczak@wskz.pl,
ORCID: 0009-0002-0457-4434
* Correspondence author

Purpose: The purpose of this study is to identify and analyze the key factors that enhance data security in outsourcing processes. The research aims to provide practical recommendations for organizations seeking to mitigate risks associated with the transfer and management of sensitive information in an outsourcing context.
Design/methodology/approach: The study employed a quantitative approach, utilizing a structured survey conducted in 2023 on a sample of 723 respondents. The collected data were analyzed using multiple correspondence analysis (MCA) to identify patterns and relationships between variables related to data security practices.
Findings: The research highlights that developing a comprehensive data security policy, employing advanced encryption technologies, conducting regular security audits, and fostering employee awareness significantly enhance data security in outsourcing processes. The findings emphasize the interconnectedness of these factors and their collective role in minimizing security risks.
Research limitations/implications: The study is limited by its reliance on a single quantitative method and a uniform sample, which may not fully capture sectoral or regional variations in outsourcing practices. Future research should explore qualitative methods and a more diverse sample to deepen the understanding of contextual factors affecting data security.
Practical implications: The study provides actionable insights for organizations to improve data security through structured policies, technological advancements, and targeted training programs. It underscores the importance of collaboration with outsourcing providers to ensure adherence to high security standards.
Social implications: Improved data security in outsourcing processes enhances trust between organizations, clients, and stakeholders. It contributes to broader societal benefits by safeguarding personal and sensitive information, thereby reducing the likelihood of data breaches and their associated consequences.
Originality/value: This study integrates theoretical perspectives with empirical findings, offering a comprehensive understanding of data security challenges in outsourcing. The use of MCA provides a novel approach to identifying the interrelations between key determinants, delivering valuable insights for both academics and practitioners in the field.
Keywords: outsourcing, data security, contracting company, project, survey.
Category of the paper: research paper.

1. Introduction

Modern organizations increasingly decide to outsource as a tool enabling cost optimization, access to specialist knowledge and increased operational flexibility. Along with the dynamic development of this cooperation model, the importance of issues related to data security is growing, which is becoming one of the key challenges in the process of outsourcing functions to external entities (Uhl-Bien, Arena, 2017). The problem of data protection in outsourcing is becoming particularly important in the face of the growing number of cyber threats, tightening legal regulations and the growth of expectations of customers and business partners. Data is a strategic resource of an organization, and its loss, theft or unauthorized access can lead to serious financial, legal and image consequences (Yin et al., 2020).

Taking up the topic of data security determinants in outsourcing processes results from the need to deepen knowledge in an area that is crucial for maintaining the integrity and stability of modern enterprises. The importance of this issue is particularly visible in the context of globalization and digitalization of the economy, where data is often processed and stored outside national borders, which additionally complicates their protection. This article attempts to analyze the factors influencing the effectiveness of data security activities in outsourcing, focusing on technological, organizational and educational aspects.

The article consists of several parts, which in a way lead to a full understanding of the discussed problem. The introduction presents the justification of the undertaken topic and discusses its importance in the context of contemporary business challenges. Then, a literature review and the most important theoretical concepts related to data security in outsourcing are presented. The next part describes the research methodology, including the use of multivariate correspondence analysis (MCA) and the characteristics of the studied sample. The results of the study are presented in the form of a detailed analysis, which identifies the most important determinants of data security. The final part discusses the conclusions from the conducted research, presents practical recommendations for companies and indicates future directions of research in this area.

The aim of the article is to identify and analyze factors that increase data security in outsourcing processes and to indicate practical solutions that can be used by organizations to minimize risk. The added value of the work is to combine a theoretical perspective with the results of empirical research, which allows not only to understand the complexity of the discussed problem, but also to develop practical tips for enterprises. The article contributes to the development of knowledge on data security management in the context of outsourcing, while emphasizing the importance of a multi-faceted approach to information protection in a dynamic and global business environment.

1.1. The essence of an outsourcing venture

The essence of an outsourcing project is that an organization outsources specific processes, functions, or activities to external service providers, which allows it to focus on key areas of activity and manage resources more effectively (Pearson, Benameur, 2010). Outsourcing is a practice that has gained popularity in many sectors, including information technology, logistics, finance, and administration (Zhang, Liu, 2010) . The decision to implement outsourcing usually results from the need to optimize costs, improve the quality of services, access to specialist knowledge, or flexibility in adapting to changing market conditions (Zhen, Xie, Dong, 2021). The fundamental assumption of outsourcing is to use the experience and infrastructure of an external provider, which allows the ordering party to avoid the need to invest in resources that could be expensive and time-consuming to build and maintain. Outsourcing service providers typically offer specialized solutions based on industry best practices that increase operational efficiency and process quality (Wang, Chow, Wang, Ren, Lou, 2011).

However, an outsourcing undertaking involves not only benefits but also challenges that require appropriate management (Cullen, Seddon, Willcocks, 2005). A key element is building a partnership relationship between the outsourcing company and the service provider. This cooperation should be based on trust, transparency and clearly defined rules (Ateniese et al., 2007). In particular, outsourcing agreements must contain precise provisions regarding quality standards, deadlines, responsibilities of the parties and monitoring and reporting mechanisms (Chow et al., 2009). The lack of clear rules can lead to misunderstandings and potential financial losses (Subashini, Kavitha, 2011).

An important aspect of an outsourcing project is managing the risk that results from transferring part of the company's activities to external entities. This applies in particular to data protection, process integrity and compliance with legal regulations (Quelin, Duhamel, 2003). Outsourcing companies must pay special attention to the selection of suppliers, assessing their credibility (Nassimbeni, Sartor, Dus, 2012), competences and ability to ensure security and compliance with industry standards. Outsourcing can also affect the organizational culture and employee engagement (Ravichandran, 2016). Transferring part of the functions to external suppliers can be perceived by the staff as a threat to their professional position, which requires appropriate change management in the organization. It is important for the company to clearly communicate the goals and benefits of outsourcing and to engage employees in the adaptation processes (Porter, Heppelmann, 2014).

Outsourcing can give organizations greater operational flexibility, especially in the context of changing market conditions (Bertino, 2009; Chakrabarty, 2006). Handing over tasks to external specialists allows for faster adaptation to new requirements, introduction of innovations and scaling of operations in response to growth or decline in demand. However, for an outsourcing undertaking to be effective, a strategic approach is necessary, which takes

into account both potential benefits and risks. Proper management of outsourcing can bring long-term benefits in the form of increased efficiency, reduced costs and improved competitiveness in the market.

1.2. The importance of data security for the company commissioning the outsourcing project

In the context of an outsourcing undertaking, the security of the outsourcing company's data plays an extremely important role (Ren, Wang, Wang, 2012). Modern organizations base their operations on data, which is the basis for making decisions, building strategies and maintaining a competitive advantage. Transferring part of the processes to an external service provider means that key company information, such as customer data, financial data or data related to operational processes, must be properly protected to prevent their loss, unauthorized access or breach. Data security in such a context is particularly important due to the complexity of the relationship between the company and the service provider (Li, Li, Chen, Lee, Lou, 2014). When outsourcing processes, the organization relies to a large extent on the capabilities and infrastructure of the provider, which is why it is crucial for the outsourcing partner to comply with the highest standards of data protection. The lack of appropriate security measures can lead to serious consequences, such as loss of customer trust, high financial penalties resulting from non-compliance with regulations, and even permanent damage to the organization's reputation (Turban et al., 2018).

One of the most important aspects of data security in outsourcing is ensuring its confidentiality. Organizations often work with sensitive information, which may include personal data of customers, trade secrets or details of research and development projects (Galvin, 2019). The confidentiality of this information must be secured both through appropriate technological mechanisms, such as encryption, and clear provisions in outsourcing agreements. It is important that suppliers are obliged to comply with principles consistent with international standards, such as GDPR or ISO 27001.

Data integrity is another key aspect that is particularly important in the context of outsourcing. This means that data must be stored and processed in a way that guarantees its accuracy and completeness. Any errors or manipulations can lead to incorrect business decisions and, consequently, to financial or operational losses. In practice, this means the need to use advanced monitoring systems that allow for the rapid detection and elimination of potential breaches (Kamara, Lauter, 2010; Kern, Willcocks, Van Heck, 2013; Murphy, 2024). Data availability protection is another pillar of security in outsourcing. Companies must be sure that their data will be available whenever they are needed, regardless of the circumstances. This is especially true in crisis situations, such as system failures, cyberattacks or logistical problems on the supplier's side. Therefore, it is important that outsourcing agreements include business continuity mechanisms such as backups, contingency plans, and service level agreements (SLAs) (Raišienė, Bilan, Smalskys, Gečienė, 2019).

Data security in outsourcing is not limited to technical aspects (Wang, He, Tang, 2015). An appropriate organizational culture that promotes awareness of threats and responsibility for protecting information is also crucial. Outsourcing companies must ensure that both their own staff and the supplier's staff are properly trained in good security practices (Qureshi, 2016).

Finally, the importance of data security in outsourcing also stems from growing regulatory requirements and market expectations. Customers and business partners increasingly expect organizations to be able to demonstrate a high level of information protection, which poses additional challenges for companies in terms of monitoring and reporting security activities. Therefore, proper data security management is becoming not only an operational requirement but also a strategic success factor in long-term outsourcing cooperation (Arshad, Ahmad, Maynard, 2022).

1.3. Factors that increase the security of the outsourcing company's data during the outsourcing process

Increasing the security of the outsourcing company's data during the outsourcing process requires a multi-faceted approach that takes into account both technological, organizational and educational aspects. One of the key factors is the development and implementation of a coherent data security policy. Such a document should clearly define the principles of data management, procedures for handling incidents and requirements for outsourcing service providers (Annarelli, Colabianchi, Nonino, Palombi, 2021). The security policy should be dynamic, which means it should be regularly updated in response to changing threats and technological developments. The use of data encryption is one of the most important technical measures in data protection. Encryption allows you to protect information from unauthorized access, both during data transfer and storage. In the context of outsourcing, where data is often transferred between different locations and stored in the cloud, the use of advanced cryptographic methods becomes particularly important. The implementation of encryption should cover both data in motion and data at rest, which minimizes the risk of their interception or theft.

Another factor that increases data security is the regular conduct of security audits (Wang, Wang, Ren, Cao, Lou, 2012). These audits allow for the assessment of the effectiveness of implemented data protection measures and the identification of potential gaps and threats. They should be conducted both internally, by the organization's security department, and externally, by independent auditing entities. The results of audits should be the basis for taking corrective and improvement actions, which allows for continuous improvement of security standards (Infinit-O Global, 2022).

Building awareness among employees is an equally important element of data protection. In the context of outsourcing, where interaction between the outsourcing company’s staff and the service provider is inevitable, employee education plays a key role in minimizing the risk of human errors. Training should cover topics such as recognizing social engineering attacks,

adhering to security policies, and responsibility for data protection. Aware and trained employees are the first line of defense against threats related to improper data processing (Pandita, Singhal, 2017).

In addition to the above activities, it is also important to implement mechanisms for monitoring and reporting data-related activities. Constant supervision over access to data and analysis of system logs allow for quick detection of unauthorized activities and appropriate response. As part of outsourcing, it is important for these mechanisms to also be used by service providers, which should be included in agreements regulating cooperation (Ghosh, Scott, 2008; Gupta, Puranam, Srikanth, 2006). An additional factor that increases data security is the use of a multi-layered protection strategy. This means combining various technologies and procedures, such as encryption, multi-factor authentication, access control, or backup. An integrated approach provides greater resistance to various threats, both those related to cyberattacks and system failures (Infinit-O Global, 2022).

In summary, data security in the outsourcing process can be effectively increased by combining appropriate technologies, procedures and educational activities. Clear rules of cooperation with suppliers, appropriately selected technical tools and a conscious approach to security management at every stage of project implementation are of key importance. Only such a comprehensive approach allows for minimizing risk and ensuring data protection in a dynamic environment of external cooperation.

1.4. Research Methodology

The aim of the conducted research was to determine the key determinants of data security in the context of business process outsourcing and to understand their mutual relations in the perception of people involved in such ventures. The research aimed to deepen knowledge about practices that increase data security, such as developing a security policy, using encryption, conducting audits and building awareness among employees. The research hypothesis assumed that individual activities related to data security have a different impact on the perception of their importance and are to a different extent related to organizational and technical factors.

The research asked questions about which activities have the greatest impact on the perception of data security and what are the relationships between individual determinants in terms of their effectiveness. Particular attention was paid to issues related to technology, audits and education, as well as their mutual relationships and differences in the perceptions of respondents.

The research method used was a survey conducted in 2023 on a sample of 723 respondents. The survey allowed for collecting quantitative data on opinions on the importance of various practices related to data security in outsourcing processes. Multivariate correspondence analysis (MCA) was chosen to analyze the obtained data. The aim of using this method was to identify patterns and relationships between the variables studied, which allowed for presenting their complex structure in two dimensions. Thanks to the MCA analysis, it was possible to better

understand the dynamics of the relationships between the determinants of data security, as well as to indicate those activities that play a key role in data protection within outsourcing.

1.5. Presentation of Research Findings

The research aimed to determine the determinants of data security in companies commissioning outsourcing projects. The analysis included the opinions of 723 respondents in relation to four key areas related to data security (see Table 1).

Table 1.
Determinants of data security of the contracting company during an outsourcing project (N = 723)

Variable	Definitely not	Rather not	I don't have an opinion	Rather yes	Definitely yes
Development of data security policy (1)	34	71	113	228	277
Using data encryption (2)	47	59	102	221	294
Conducting regular security audits (3)	39	68	117	214	285
Creating security awareness among employees (4)	43	54	125	229	272

Source: Own study based on research.

In the case of the variable concerning the development of a data security policy, 34 people strongly disagreed with this solution, while 71 respondents rather disagreed with it. A neutral position on this issue was adopted by 113 people, while 228 respondents rather approved of this approach. It was strongly supported by 277 respondents. The second variable concerned the use of data encryption. In this category, 47 people declared that they definitely did not see the need to introduce this solution, while 59 respondents rather disagreed with it. Neutral opinions were expressed by 102 respondents, while 221 people considered it rather justified. Strong support was expressed by 294 respondents, which indicates significant appreciation for encryption as an element increasing data security. The third variable referred to conducting regular security audits. In this category, 39 respondents strongly disagreed with the need to implement them, while 68 people rather expressed such a position. Neutrality towards this practice was demonstrated by 117 respondents, while 214 people assessed it as rather beneficial. This solution was strongly supported by 285 respondents, which indicates its significant importance in the context of data protection.

The fourth variable analyzed the impact of creating security awareness among employees on improving data security. 43 respondents expressed strong opposition to this approach, while 54 people rather did not support this idea. Neutral opinions were declared by 125 respondents, and 229 respondents assessed this solution as rather effective. It was strongly supported by 272 people, which indicates wide acceptance of activities related to educating employees about data security.

Figure 1 presents the results of the multivariate correspondence analysis (MCA) for four variables: "Policy Development", "Data Encryption", " Security Audits" and "Awareness Creation". Each variable is embedded in two dimensions – Dimension 1 and Dimension 2 – which allows for visualization of the mutual relationships between them and their characteristics. Dimension 1, which is the horizontal axis, illustrates the differences in the importance assigned to individual variables in the analysis.

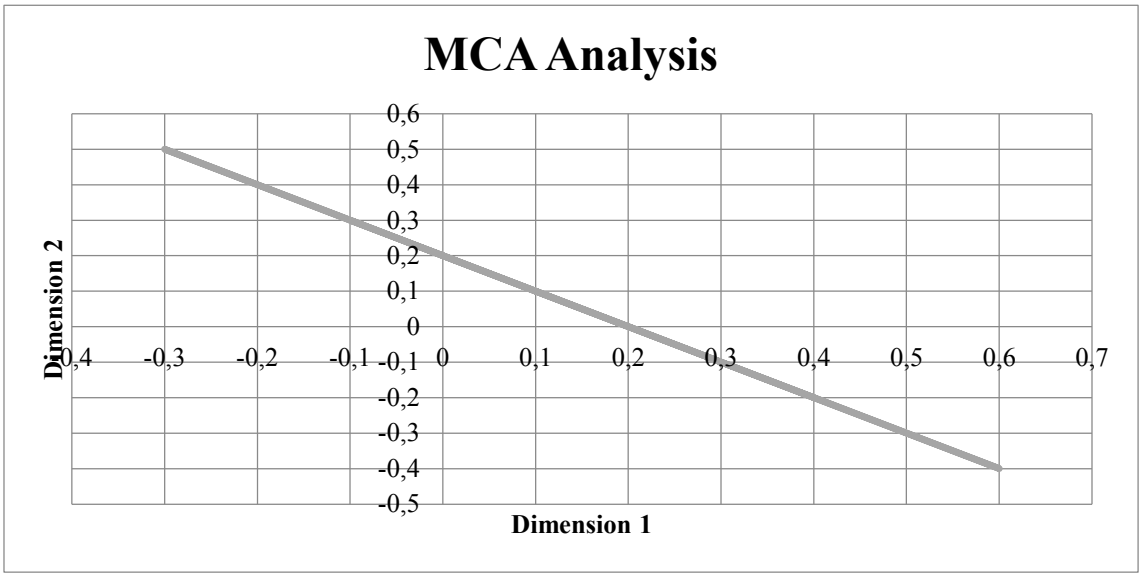

Figure 1. MCA Analysis.

Study: own.

In this dimension, variables such as "Policy Development" and "Security Audits" have positive values, which may suggest their strong connection with factors with a higher priority in the perception of respondents. In turn, variables "Data Encryption" and "Awareness Creation" have negative values, which may indicate a different nature of their connections or a lower importance perceived by respondents in the studied context. Dimension 2, located on the vertical axis, refers to the second factor differentiating the studied variables. In this dimension, "Data Encryption" and "Awareness Creation" have positive values, which indicates their clearly distinct profile in comparison to "Policy Development" and "Security Audits", which have negative values. Such a difference can be interpreted as an indication of a more practical use of positive variables in comparison to the more procedural nature of negative variables.

"Policy Development" is located in the first quadrant of the graph, which suggests its positive correlation with both Dimension 1 and Dimension 2. This may indicate that the development of a data security policy is perceived as important in the context of the studied characteristics. "Data Encryption" is located in the second quadrant, which indicates its positive correlation with Dimension 2 and negative with Dimension 1, emphasizing the specific role of encryption as a technical aspect of security. "Security Audits", located in the fourth quadrant, are characterized by a positive value of Dimension 1 and a negative value of Dimension 2,

which may indicate their importance as a control tool. "Awareness Creation" in the third quadrant indicates a strong connection with the educational and awareness dimension of security activities.

Figure 1 enables easy identification of similarities and differences between variables and their positioning on two key dimensions. This makes it a useful tool for analyzing the relationships between variables and allows for further drawing conclusions about their role in the data security process in the context of outsourcing.

2. Discussion

The conclusions from the conducted research indicate that the determinants of data security in the context of outsourcing are diverse in terms of importance and perceived effectiveness. The development of a data security policy, which obtained high values in both dimensions of the MCA analysis, was identified as one of the most important activities. This results from the fact that clearly defined rules and procedures are the foundation of effective data security management. It also provides the basis for other activities, such as audits or employee education, which can only be effectively implemented within the framework of a well-defined security management system.

Data encryption, which received mixed results in two dimensions of the analysis, was assessed as a key element of technical data protection, although its perception is strongly dependent on the specifics of the organization and the level of technological advancement of the respondents. Respondents who rated encryption highly most often indicated its ability to protect data from unauthorized access, especially in the context of external cooperation. In turn, lower ratings may result from implementation difficulties, such as costs or the need for specialist knowledge. Security audit was identified as a practice with high control value. The results indicate that conducting regular audits increases trust in the security mechanisms used, allowing for early detection of potential gaps and threats. Audits also play a preventive role, affecting the responsibility of external entities for compliance with security standards. Nevertheless, some respondents indicated limitations of this practice, such as time consumption and dependence on the quality of the procedures performed.

Creating awareness of security among employees was assessed as an important, yet complementary element of the security strategy. The results suggest that employee education increases the effectiveness of other activities, such as security policy and data encryption, by reducing the risk of human errors. However, lower values in the first dimension of the analysis may be due to the perception of educational activities as less directly related to technological aspects of security, which does not reduce their importance in the overall strategy.

The MCA analysis also showed that different determinants are strongly interconnected. Developing a security policy is a key starting point, on which other activities, such as encryption or audits, are based. Educational activities, in turn, play a supporting role, increasing the overall effectiveness of the remaining elements of the security strategy. The results also indicate the need to integrate technical and organizational activities, which allows for a more comprehensive and effective approach to data protection in outsourcing processes.

In summary, the research confirms that effective data security management requires a multi-faceted approach, taking into account both technological and organizational elements. Security policy, regular audits and the use of advanced technologies such as encryption, supported by building awareness among employees, are of key importance. Such an approach allows to minimize the risk and ensure effective data protection within the framework of outsourcing cooperation.

To effectively manage data security in outsourcing processes, companies should focus on several key activities. First of all, it is necessary to create a comprehensive data security policy that will become the basis for all security practices. Such a policy should clearly define standards, procedures and responsibilities both within the organization and in relations with outsourcing partners. It is equally important to conduct regular security audits, which allow for early detection of gaps and potential threats. These audits should be carried out systematically and take into account both technological and organizational aspects, which allows for a full assessment of the effectiveness of the implemented actions. Commissioning audits to independent entities can additionally increase the objectivity of the results.

Implementing advanced technologies, such as data encryption, should be a priority for every organization. Encryption protects data from unauthorized access, especially when transferring information between a company and an outsourcing service provider. It is important that this technology is used consistently and adapted to the specifics of the company's operations. The role of employee education cannot be forgotten either. Regular data security training is crucial because it allows not only to increase knowledge about threats, but also to build awareness of responsibility for protecting information. Employees should not only know the basic principles of security, but also be able to recognize more advanced threats, such as attempted social engineering attacks.

It is also important to develop transparent relationships with outsourcing service providers. Building trust through clear communication of requirements and joint planning of data security activities can significantly increase the effectiveness of the actions taken. It is important that the cooperation is grounded in detailed agreements regulating data protection standards, and their compliance is systematically monitored. An approach that combines technological, organizational and educational aspects allows companies to manage data protection risks more effectively. Implementing these activities not only strengthens security, but also builds trust among customers and partners, which translates into the stability and long-term development of the company.

The key studies highlight important determinants of data security in outsourcing, such as security policies, encryption, audits, and employee education. However, the research has limitations, including reliance solely on quantitative methods, lack of consideration for specific sectors (e.g., medical, financial), and omission of the dynamic development of new technologies like artificial intelligence or blockchain. Additionally, the uniform sample and restriction to MCA analysis do not fully capture the complexity of the issue. Despite these weaknesses, the studies provide valuable practical insights and a solid foundation for further exploration.

The new knowledge brought by the conducted research includes a detailed identification and analysis of data security determinants in outsourcing processes, such as security policies, data encryption, audits, and employee awareness-building. The study demonstrated that the effective and integrated implementation of these elements significantly reduces risks related to data loss or unauthorized access. One key conclusion is the necessity of developing a coherent security policy, which serves as the foundation for other actions, such as audits and education. It was also shown that data encryption is perceived as a crucial element of technical protection, though its effectiveness may be limited by implementation costs and technological requirements.

Another important finding is the role of employee education in minimizing the risk of human errors, which enhances the effectiveness of other protective measures. Moreover, the analysis of interdependencies among security determinants highlights the need for a comprehensive approach that integrates technological, organizational, and educational aspects. The conclusions provide organizations with practical guidelines for improving data security in outsourcing and serve as a basis for further research in this area.

The conducted research is of significant importance for the practice of data security management in outsourcing processes, particularly in the context of increasing cyber threats and tightening legal regulations. Its findings contribute new knowledge about the key determinants of effective data protection, enabling organizations to better understand which actions are most effective in minimizing risks.

The impact of the research on the broader field includes supporting organizations in developing more advanced data protection strategies that can be tailored to various sectors and specific industry needs. Moreover, highlighting the importance of elements such as security policies, encryption, audits, and education provides valuable insights for both practitioners and further scientific studies. The information obtained can be used to develop comprehensive security standards applicable across different organizations. The findings can also serve as a starting point for further exploration of the topic, particularly in the context of dynamic technological changes such as the development of artificial intelligence and blockchain. Additionally, this research may inspire analyses in specific economic sectors, where data protection issues are of particular importance, such as the financial, medical, or educational sectors.

3. Conclusions

Comparing the results of the conducted studies with the findings of other researchers, one can notice both similarities and differences in the perception of the determinants of data security in the context of outsourcing. A study published in "Issues in Information Systems" indicated that despite concerns about security, some of the largest technology companies locate their operations in India, trusting the assurances of local service providers about data protection (Ghosh, Scott, 2008). Other sources emphasize the importance of physical data protection and quality management systems in the context of outsourcing, which is consistent with the results of the discussed studies, which indicate the importance of developing a security policy and regular audits (Infinit-O Global, 2022).

The literature also draws attention to the need to use advanced cryptographic technologies to ensure secure access to data stored in the cloud, which corresponds to the results of the discussed studies, emphasizing the importance of data encryption (Bertino, 2009). Furthermore, a review of the literature on secure outsourcing of computations indicates the need to use various security methods to cope with the threats associated with transferring IT functions to external entities (Wang et al., 2015).

In the context of IT outsourcing, other studies identify factors influencing organizations ' decisions to outsource IT security functions, emphasizing the importance of both managerial and legal aspects (Arshad et al., 2022). Furthermore, the analysis of risks related to outsourcing and offshoring services indicates the need to apply preventive and corrective measures to minimize potential threats (Nassimbeni et al., 2012). The results of the conducted research are consistent with the literature on the subject, emphasizing the importance of developing a security policy, using advanced cryptographic technologies, and regular audits to ensure data security in outsourcing processes. At the same time, differences in the perception of some aspects, such as employee education, may result from the specificity of the studied samples and the cultural and organizational context.

The limitations of research based on the analysis of data security determinants in outsourcing processes resulted from several factors. First, the research was based on data collected using a survey, which limits the possibility of in-depth qualitative analysis. Respondents could interpret the questions in a subjective way, which potentially influenced the results. In addition, the method used does not allow for full capture of the complex relationships between variables in the dynamically changing outsourcing environment, especially in the context of cultural and technological differences between companies.

The second limitation was the uniform sample of 723 respondents, which, although large in number, did not fully reflect the diversity of entities using outsourcing. The sample did not include specific sectors, such as the medical or financial industries, which may have different data security challenges. Additionally, the lack of data on the geographic origin of respondents

limited the ability to analyze the impact of regional factors on the results. Another limitation was the lack of consideration of dynamic changes in data security technologies, which could have influenced the perception of some security determinants. Therefore, the results may not fully reflect current technological trends and innovations, such as the use of artificial intelligence or advanced encryption methods.

Finally, the study's limitations also related to the choice of MCA analysis as the main analytical method. Although it allows for the identification of patterns and relationships between variables, its results are more difficult to interpret in the case of more complex relationships. The lack of complementary statistical analyses, such as regression or cluster analysis, may have limited the fullness of conclusions drawn from the obtained data.

In conclusion, the limitations of the study result mainly from the adopted methodology, sample characteristics and the lack of consideration of the dynamically changing technological environment. However, the results constitute an important starting point for further research, which can deepen and extend the conclusions, taking into account a broader context and more diverse analytical tools. Future research directions may focus on a more comprehensive understanding of the determinants of data security in the context of various economic sectors. An important area for exploration is the analysis of specific industry requirements, such as healthcare, the financial sector or education, where data protection is of particular importance due to its sensitivity and legal regulations. The research may also take into account geographical and cultural differences in the perception of data security, which would allow for adapting the strategy to regional needs and requirements.

An important aspect of further research may be the analysis of dynamic changes in technologies related to data protection, such as the development of artificial intelligence, blockchain or advanced encryption methods. Examining their impact on the perception of data security and the effectiveness of the practices used could provide valuable tips for organizations looking for modern solutions in this area. Another area to explore is the role of education and employee awareness in the context of minimizing the risk associated with human errors. Research could focus on assessing the effectiveness of various training methods and identifying best practices in building a security culture in organizations using outsourcing.

It is also possible to deepen the analysis of cooperation between companies and outsourcing service providers, especially in terms of building trust and transparency in business relationships. Research could include aspects of contract negotiations, mechanisms for monitoring and auditing suppliers, and the impact of these activities on the overall quality of data security management. Finally, an interesting direction of research would be to examine the effectiveness of integrating technologies and organizational strategies in the context of data security. Analyzing the synergies between technologies and security policies could provide knowledge on the most effective combinations of actions that provide holistic data protection in a dynamically changing business environment. Future research could provide more detailed and contextual recommendations that would support organizations in developing effective data security strategies.

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FACTORS DETERMINING CUSTOMER DATA SECURITY IN AGILE ORGANIZATIONS

Maria KOCOT[1*], Bartosz BŁASZCZAK[2]

[1] University of Economics in Katowice; maria.kocot@ue.katowice.pl, ORCID: 0000-0001-5150-3765
[2] Higher School of Professional Education Wroclaw; bartosz.blaszczak@wskz.pl,
ORCID: 0009-0002-0457-4434
* Correspondence author

Purpose: The purpose of this article is to identify and assess key factors that impact customer data security in agile organizations. The study aims to determine priorities in data security management and to indicate patterns in how respondents perceive these factors.
Design/methodology/approach: The study was conducted using a survey method on a sample of 303 respondents in April-May 2023. The results were subjected to multivariate correspondence analysis (MCA) to identify relationships and patterns between data security factors.
Findings: The results indicate that factors such as data encryption systems, access control, real-time monitoring, and employee training are key. The MCA analysis revealed the interconnections between these factors and identified areas for further optimization in data security.
Research limitations/implications: The study is limited to agile organizations and relies on subjective opinions of respondents. The results may be extended in the future to other types of organizations or through the use of mixed methods to deepen the analysis.
Practical implications: The presented results can support organizations in developing effective customer data protection strategies. Recommended actions include implementing advanced security systems, regular audits and intensifying employee training.
Social implications: Improving customer data security strengthens consumer trust and loyalty while contributing to a more secure digital environment. These activities also respond to societal expectations related to respect for privacy and ethics in data management.
Originality/value: The article provides a unique perspective on the issue of customer data security in the context of agile organizations. The use of MCA analysis allowed for an in-depth assessment of patterns and relationships between factors, which enriches the literature on the subject and supports decision-making in organizations striving for operational agility.
Keywords: data security, client, agile organizations, MCA analysis, digitalization.
Category of the paper: research paper.

1. Introduction

The issue of customer data security in agile organizations is becoming crucial in the context of contemporary challenges posed by digital transformation and dynamically changing market conditions (Awasthi, Awasthi, 2023). The ongoing digitalization of business processes, the growing importance of data as a strategic resource, and the growing number of cyber threats make data protection not only an operational priority, but also the foundation for building trust and long-term relationships with customers. The conducted research focused on the analysis of factors determining customer data security in agile organizations allows for a better understanding of which management elements in this area are key and what challenges are associated with their implementation (Kurnia, Chien, 2020).

The article begins with a theoretical introduction that focuses on the importance of protecting customer data in the context of organizational agility. Then, the research objective is presented, which is to identify and assess key factors for ensuring data security in agile organizations. The research methodology used is also described, including the use of a survey conducted on a sample of 303 respondents and multivariate correspondence analysis (MCA), which allows for the identification of patterns in the respondents' answers. The subsequent sections of the article present detailed research results, including the respondents' assessments of individual factors and the analysis of the relationships between them. The research conclusions are supplemented with recommendations that can support organizations in designing effective data protection strategies.

Taking up this topic has significant practical and theoretical value. Protecting customer data is not only a legal requirement, but also a key element of building a competitive advantage (García-Granero, Piedra-Muñoz, Galdeano-Gómez, 2020). The research results provide insight into areas that require special attention and indicate the importance of a holistic approach to security management. The article adds value by identifying the most important factors affecting customer data security and by formulating specific recommendations that can be implemented by agile organizations. Thanks to the applied MCA analysis, it was possible to deepen the understanding of the mutual relationships between the studied factors, which enriches the existing literature on the subject with new perspectives and conclusions.

1.1. The Importance of Keeping Customer Data Secure

Ensuring the security of customer data is a key element of the functioning of modern organizations, especially in the era of dynamic development of digital technologies and the growing importance of data as a strategic resource. Customer data, both personal and business, are one of the most valuable assets of every organization, which is why their protection is not only a legal requirement, but also a fundamental aspect of building trust and reputation (Jones, Adam, 2023).

Customer data security directly affects the perception of an organization as professional, responsible, and trustworthy. As customers become more aware of the risks associated with privacy breaches, expectations of organizations regarding data protection are growing significantly. Data loss or improper protection can lead to serious consequences, such as loss of trust, decreased customer loyalty, and a negative impact on the organization's financial results. Moreover, in an era of increasingly stringent legal regulations, such as GDPR in the European Union, improper management of customer data can result in severe financial and legal penalties (LexDigital, 2022).

From the perspective of agile organizations, which are flexible and able to quickly adapt to changing market conditions, ensuring the security of customer data is particularly important. Such organizations often operate in a highly digitalized environment and use advanced technological tools to manage processes and communicate with customers (EITT, 2024). As a result, their activities are exposed to various threats, such as hacker attacks, data leaks or unauthorized access to systems (Chen, Siau, 2020). Ensuring data security requires a systemic and multi-faceted approach. A key element is the use of advanced technologies, such as data encryption, access control, regular security audits or real-time monitoring. At the same time, education of employees plays an important role, who must be aware of the threats and properly trained in data protection. Implementing procedures for handling security incidents helps minimize the potential effects of breaches (LexDigital, 2022).

Customer data security also has an important ethical dimension. Organizations are responsible for protecting the information entrusted to them, and any failure to do so can be perceived as a lack of respect for customers and their privacy (Joiner, 2019). Therefore, building an organizational culture in which data protection is a priority plays a key role in long-term business success (ODO24, 2024). In the context of contemporary challenges such as globalization, the development of cloud computing, or the growing number of cyberattacks, ensuring the security of customer data is not a one-time action, but a process that requires continuous optimization and adaptation to new threats. Organizations that effectively integrate data security management with daily operations not only gain a competitive advantage, but also build lasting relationships with customers based on trust and loyalty (Luo, Ren, Cao, Hong, 2020).

1.2. Customer Perception in Agile Organizations

The customer in agile organizations is a key element of the strategy of action, because it is the customer who is the center of all processes and decisions (Raschke, 2010; Womack, Jones, 2003; Yang, Liu, 2012). In the context of organizational agility, the customer is not perceived only as a recipient of a product or service, but as an active participant whose needs, expectations and opinions significantly shape the functioning of the organization. This way of thinking results from the philosophy of agility, which assumes dynamic adaptation to the changing environment and continuous improvement of the offer (Gadomska-Lila, 2013). In agile

organizations, the customer is perceived as a co-creator of value. The processes of designing and implementing products or services take place with their participation, for example by collecting feedback, organizing workshops or engaging in testing phases (Chen, Li, 2021). Thanks to this, organizations can better understand the real needs of customers, which allows for the delivery of solutions that are more tailored and meet their expectations. Such interaction has a positive impact on building long-term relationships based on mutual trust and commitment (Mrugalska, Ahmed, 2021).

Agile organizations also perceive the customer as a source of knowledge and inspiration. Information obtained from customers is an important element in the process of making strategic and operational decisions (Munodawafa, Johl, 2019). Thanks to this, organizations can respond to changing trends, identify new market opportunities, and anticipate future customer needs. Instead of relying on outdated patterns of action, agile organizations dynamically adapt to the environment, which allows them to remain competitive. Another important aspect of customer perception in agile organizations is personalization (Doz, Kosonen, 2008). Agile organizations strive to provide individually tailored solutions that take into account the specific preferences and expectations of each customer. Using advanced analytical tools such as big data or artificial intelligence, agile organizations are able to anticipate customer needs and provide them with the right products or services at the right time. Personalization not only increases customer satisfaction, but also strengthens their loyalty to the brand (Gao, Zhang, Gong, Li, 2020).

The customer in agile organizations is also seen as a partner in the process of building organizational value. The agile approach assumes that the relationship with the customer does not end at the sales stage, but lasts throughout the entire life cycle of the product or service. Regular interactions and collecting feedback allow organizations to continuously improve the offer and increase the value delivered to customers. However, such an approach requires openness to dialogue and flexibility in responding to criticism and changing needs (Rahimi, Mansouri, 2019). In agile organizations, the importance of the customer is not limited only to activities related to marketing or sales. The customer is an integral part of the organizational culture, in which every employee understands that their actions have a direct impact on the customer's experience. Thanks to this, agile organizations can effectively build their reputation as a trustworthy partner who can deliver high-quality solutions quickly and efficiently (Nath, Agrawal, 2020).

The perception of the customer in agile organizations also includes the aspect of social and ethical responsibility (Porter, Kramer, 2006). Customers increasingly expect organizations to operate in a transparent, ecological and ethical manner. Agile organizations try to respond to these expectations by implementing solutions promoting sustainable development and taking into account the needs of local communities in their activities (Borowski, 2021; Fiddler, 2017). This holistic approach allows an agile organization not only to meet customer needs, but also to build a positive image and engage customers in activities with a wide social reach.

1.3. Customer Data Security in Agile Organizations

Customer data security in agile organizations is an important element of management that affects the integrity of business processes and the reputation of the organization (BCO-Integrity, 2024). In the era of digitalization and a dynamically changing technological environment, ensuring customer data protection is becoming a priority, especially in the context of agile organizations that must constantly adapt to new challenges and threats (Attar, Almusharraf, Alfawaz, Hajli, 2022). Data security is not only a legal requirement, but also the foundation for building customer trust and long-term cooperation (Prieto, Talukder, 2023). One of the key elements of data protection in agile organizations is the use of encryption systems and advanced data protection technologies. Encryption is a basic mechanism that protects information from unauthorized access. However, its effectiveness depends on the quality of the algorithms used and regular updates of security systems, which should be adapted to changing attack methods. Agile organizations that are flexible in their operations must quickly implement new technologies and respond to potential threats to minimize the risk of data breaches (Rosário, Raimundo, 2021).

Another important aspect is access control and authorization, which help reduce the risk of unauthorized use of data. The introduction of multi-level user verification procedures, such as multi-factor authentication, enables effective management of access to sensitive information. Access control is particularly important in agile organizations, where cooperation between teams often requires dynamic allocation and modification of permissions (He, Harris, 2021). Appropriate access management allows for maintaining a balance between agility and data security. Regular security audits are another pillar of customer data protection. Audits enable the identification of potential security gaps and assessment of the effectiveness of implemented procedures. In agile organizations, these audits should be carried out periodically to adapt protection systems to changing operational and technological conditions. Their results allow for making informed decisions regarding further investments in security and minimizing the risk of breaches (Sedej, Justinek, 2021).

An essential element of the security strategy in agile organizations is employee education in the field of data protection. Training in this area allows to increase awareness of potential threats and develop appropriate habits in the daily use of IT systems. In the context of organizational agility, where teams work in a dynamic environment, this education must be a permanent element of the company's policy (Routledge, 2020). Employee knowledge is a key factor in data protection, because even the most advanced technologies can be ineffective in the face of human errors (Thales, 2022). Real-time monitoring and response play a key role in quickly detecting and neutralizing threats. Modern agile organizations use analytical tools that allow for continuous tracking of activity in IT systems. Implementing monitoring systems allows not only the identification of potential breaches, but also rapid response to incidents, which minimizes the risk of problem escalation (Seifollahi, Shirazian, 2021).

Protecting customer data also requires regular software and technology infrastructure updates. In agile organizations that often use modern tools and platforms, these updates are essential to ensure compliance with the latest security standards. Failure to update can lead to potential attackers exploiting known vulnerabilities, which poses a significant risk to data integrity (Syteca, 2020). Developing and implementing data breach procedures is another important element of a security strategy. In agile organizations, these procedures should be flexible to allow for quick adjustments to the specific situation. Proper incident management, including identifying the causes of the breach, informing customers, and implementing corrective measures, helps minimize the effects of breaches and rebuild customer trust (Sajdak, 2021).

In the context of agility, interdisciplinary cooperation in security management is of particular importance. Combining knowledge and experience from different areas of the organization allows for a more comprehensive approach to data protection (Brown, Jones, 2018). Teams consisting of IT experts, lawyers, managers and compliance specialists can jointly develop and implement solutions that provide a high level of data protection in a dynamically changing environment (Sherehiy, Karwowski, 2017). Ensuring the security of customer data in agile organizations requires a systemic approach that combines advanced technologies, procedures and employee awareness. These organizations must constantly adapt their strategies and practices to meet data protection challenges while maintaining the flexibility of operations and the ability to quickly respond to changing customer needs and external threats (Skyrius, Valentukevič, 2020).

1.4. Research Methodology

The aim of the research was to identify and assess key factors determining the security of customer data in agile organizations. The research aimed to indicate which elements of security management are most important from the perspective of respondents, and to analyze their mutual dependencies in the context of the dynamically changing needs of agile organizations.

A research hypothesis was formulated, assuming that there is a set of key factors with a high level of importance in ensuring customer data security, and their perception varies depending on the organizational specificity and the experiences of respondents. The study was to verify whether factors such as data encryption systems, access control or real-time monitoring are considered a priority by the majority of the study participants. Research questions were asked, which aimed to obtain detailed answers regarding the analyzed issue. In particular, it was tried to determine what are the most important factors related to customer data security in agile organizations, how respondents assess their importance and whether there are patterns in the answers that allow for grouping individual categories of factors.

The research method used in this project was a survey conducted in April-May 2023 on a sample of 303 respondents. The survey included questions on various aspects of data security management, including protection systems, audits, training, and technological infrastructure.

The collected data allowed for statistical analysis, including the use of MCA (Multiple Correspondence Analysis), which allowed for the identification of patterns and relationships between individual response categories.

MCA analysis was used to reduce the dimensionality of the data and visualize the relationships between factors, which allowed for a more precise understanding of the structure of the respondents' answers. This made it possible to indicate which of the studied factors were most closely related to the respondents' assessment and how these relationships could be used to optimize data security management practices in agile organizations.

1.5. Presentation of Research Findings

The research aimed to determine the factors determining the security of customer data in agile organizations, taking into account various areas of data management activities (see Table 1).

Table 1.
Factors determining the security of customer data in agile organizations (N = 303)

Category	Definitely not	Rather not	No opinion	Rather yes	Definitely yes
Encryption and data protection systems	20	37	59	130	57
Access control and authorization	22	40	45	128	68
Regular security audits	28	33	47	119	76
Employee data protection training	21	34	43	121	84
Real-time monitoring and response	19	42	55	118	69
Software and infrastructure updates	15	39	51	125	73
Procedures for data breaches	18	30	60	120	75
Interdisciplinary collaboration in security management	24	29	44	126	80

Study: own.

Respondents rated the importance of each of these factors on a scale from "definitely not" to "definitely yes". In the case of encryption and data protection systems, the largest number of respondents, as many as 130 people, indicated the answer "rather yes", and another 57 people chose "definitely yes", which indicates the high importance of this factor. At the same time, 37 people indicated "rather not" and 20 people chose "definitely not", which indicates a varied approach to this issue.

Access control and authorization were rated similarly, with 128 people indicating "rather yes" and 68 respondents "definitely yes". Smaller groups chose negative answers, with 40 people indicating "rather no" and 22 people "definitely no". Regular security audits received the most support in the "rather yes" and "definitely yes" groups, with 119 and 76 indications, respectively. At the same time, 28 people rated this factor as "definitely no" and 33 as "rather no". Staff training in data protection was rated particularly positively, with 121 respondents

indicating "rather yes" and 84 people "definitely yes". On the other hand, 34 people considered this factor as "rather unimportant" and 21 as "definitely unimportant". Real-time monitoring and response also received high marks, with 118 respondents choosing “rather yes” and 69 “definitely yes.” Negative responses were smaller, with 42 people choosing “rather no” and 19 choosing “definitely no.”

Software and infrastructure updates received support with 125 “rather yes” and 73 “strongly yes” responses. “rather no” and “strongly no” responses were given by 39 and 15 people, respectively. Data breach procedures also received high marks, with 120 “rather yes” and 75 “strongly yes” responses. “rather no” and “strongly no” responses were given by 30 and 18 people, respectively. Interdisciplinary collaboration in security management received 126 “rather yes” and 80 “strongly yes” responses . Negative responses were less numerous, with 29 “rather no” and 24 “strongly no.”

In order to identify patterns in respondents’ answers regarding the factors determining the provision of customer data security in agile organizations, MCA (Multiple Correspondence Analysis) analysis was conducted. This method allows for visualization of the relationships between the studied categories and assessment of which aspects are most closely related to specific dimensions of the analysis.

In the presented Figure 1, two main axes are marked, labeled "Dimension 1" and "Dimension 2", which represent dimensions of data variability. The horizontal axis (Dimension 1) explains the largest part of the variability between categories, while the vertical axis (Dimension 2) allows to capture additional differences that were not included in the first dimension. Each point on the graph corresponds to one of the analyzed categories, such as encryption and data protection systems, access control and authorization, or regular security audits.

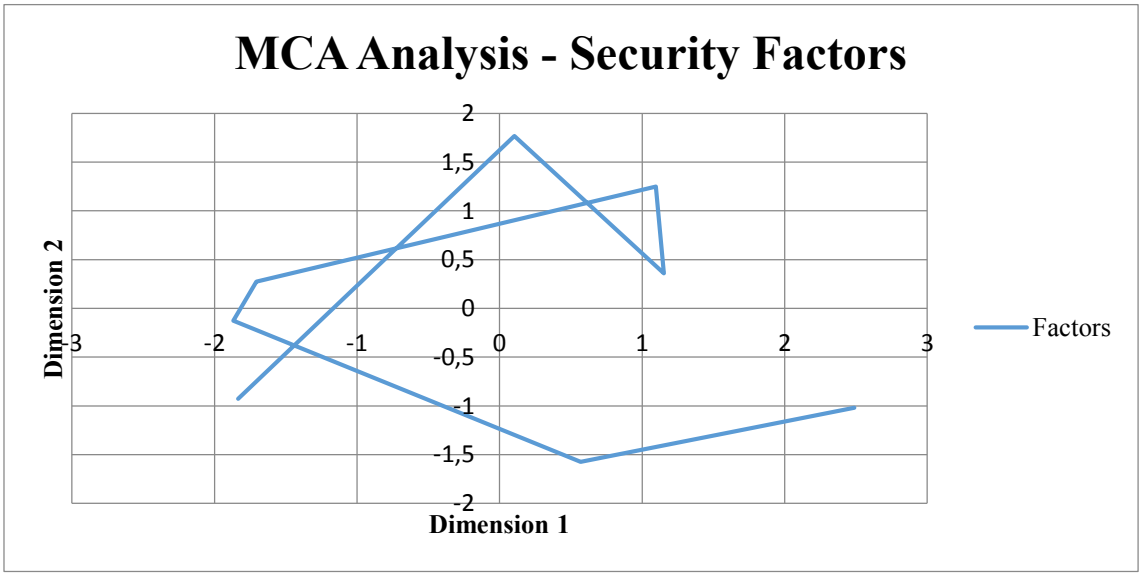

Figure 1. MCA Analysis – Security Factors.

Study: own.

The distribution of points can reveal differences in the perception of individual factors. Categories placed close to each other on the graph indicate similarity in terms of the respondents' responses, which may indicate that they are commonly perceived as important elements of ensuring security. For example, the proximity of points related to access control and encryption systems may suggest their key importance in managing data security. Outliers, located further from the center of the graph or from other categories, may indicate more specific characteristics of these factors that distinguish them from the rest. This may indicate the need to take special account of these aspects in further data security activities.

The MCA analysis was justified by the need to better understand the structure of the data, which includes multidimensional relationships between respondents' assessments. Thanks to this method, it is possible not only to indicate the most influential factors, but also to create a basis for further, more detailed analyses that can support management decisions in agile organizations. The chart is a graphical representation of the analysis results and facilitates the interpretation of key relationships between the categories studied.

2. Discussion

The research results allowed us to draw several important conclusions regarding the factors determining the security of customer data in agile organizations. First of all, it was indicated that respondents are characterized by a high awareness of the importance of actions aimed at protecting data, and individual categories, such as encryption systems, access control or staff training, received clear support as key elements in building security. However, differences in the level of assessment for individual categories indicate a different approach to their importance, which indicates a diverse perception of priorities in this area.

Data encryption and protection systems, which received high marks in the “rather yes” and “strongly yes” categories, were identified as fundamental in protecting customer data. The results suggest that these technologies are perceived as a basic measure to prevent security breaches, which indicates their widespread acceptance among respondents. Similarly, access control and authorization were considered crucial, which indicates the importance of procedures limiting access to data only to authorized persons. Such an approach minimizes the risk of unauthorized access and emphasizes the importance of consistency of security policies in organizations. Regular security audits received high support, which indicates their perception as an effective tool in identifying potential weaknesses in data protection systems. These audits, being part of prevention and monitoring, are seen as essential in the process of continuous improvement of security systems. The results emphasize the need for their cyclical conduct to ensure compliance with dynamically changing standards and technological requirements.

Data protection training was rated particularly highly by respondents, indicating its key importance in building employee awareness and responsibility. The results suggest that education in this area is an essential element of a security strategy, especially in agile organizations, where flexibility and variability of processes require the involvement of all team members. It was also emphasized that employee knowledge can act as the first line of defense in threat situations. Real-time monitoring and response were considered an important tool in the rapid identification and neutralization of potential incidents. The results indicate that dynamic and continuous monitoring of systems is perceived as a key element of proactive data security management. Real-time monitoring allows for detection of threats at an early stage, which reduces the risk of serious breaches.

Respondents also noted the importance of regular software and infrastructure updates, which underscores the need to maintain systems compliant with the latest security standards. The results suggest that neglecting this aspect can lead to serious consequences, including the exploitation of security holes by unauthorized persons. The need to develop procedures for handling breaches that enable rapid and effective crisis management and minimizing the effects of potential incidents was also mentioned. Interdisciplinary cooperation in security management was rated as an important factor, which indicates the need to involve different departments of the organization in the development and implementation of security policies. The results suggest that combining knowledge and experience from different areas, such as IT, law or management, can lead to more comprehensive and effective solutions.

Based on the MCA analysis, patterns in the perception of individual factors were identified, which allowed for the separation of the most influential elements in data security management. The proximity of individual categories on the chart indicates their mutual connections and similarity in the respondents' assessment, which can be the basis for further actions aimed at optimizing processes. The results of the MCA analysis also indicate the need for greater attention to factors that are perceived as less important, but can have a significant impact on security in specific contexts.

Overall, the research confirms the importance of a holistic approach to customer data protection in agile organizations. The results indicate that effective security management requires not only advanced technologies, but also conscious employee involvement, regular audits, and cooperation between different areas of the organization. This allows building lasting customer trust and ensuring security at a level that meets contemporary technological and social challenges. Based on the research conducted and the conclusions drawn, a number of recommendations can be formulated for companies that want to effectively manage customer data security in agile organizations. A key element of the strategy should be the adoption of a holistic approach that takes into account both advanced technologies and organizational and educational factors.

It is recommended to implement advanced data encryption systems and access control based on multi-level authentication procedures. These technologies should be regularly updated to keep up with dynamically changing threats. Organizations should also invest in real-time monitoring and response systems that allow for quick detection of security incidents and immediate preventive action.

It is important to regularly conduct security audits to identify potential gaps in systems and assess the effectiveness of implemented solutions. The results of these audits should be the basis for taking corrective actions and adapting security policies to current challenges. Introducing clear procedures for handling data breaches will allow for quick response and minimizing the effects of potential incidents.

Employee education should be a permanent element of the security strategy. Regular training is recommended to increase awareness of threats and develop appropriate habits in the field of data protection. Employees should also be informed about security procedures and the responsibility associated with their compliance.

Agile organizations should pay special attention to interdisciplinary cooperation in the field of security management. Combining the knowledge and experience of experts from various fields, such as IT, law or management, will allow for a more comprehensive approach to data protection and the development of solutions that will be consistent with both legal requirements and customer expectations.

Companies should also develop the ability to respond quickly to changing market and technological conditions. To this end, it is recommended to create flexible management structures that will allow for dynamic adjustment of security policies to new challenges. In addition, it is worth investing in the development of an organizational culture that promotes transparency, responsibility and commitment to protecting customer data.

According to the survey results, special attention should be paid to factors that are considered most important by respondents, such as encryption systems, access control, real-time monitoring and employee training. However, less obvious aspects, such as regular infrastructure updates or breach procedures, cannot be neglected, which in certain situations can be crucial for data protection.

Adopting these recommendations will allow companies to create a coherent and effective customer data security management strategy that will not only meet legal requirements, but also build customer trust and loyalty, which in the long term will contribute to increasing the organization's competitiveness in the market.

3. Conclusions

The results of the conducted research on factors affecting customer data security in agile organizations are consistent with the findings of other researchers. Particular importance is attributed to data encryption systems, which are considered a key element of information protection. As indicated by the study conducted by Thales, the lack of appropriate encryption mechanisms leads to numerous security breaches, especially in the case of data stored in the cloud (Thales, 2022). The literature also emphasizes that access control and authorization are an indispensable element of data protection. An approach based on the Zero Trust principle is increasingly recommended, which assumes that every user is a potential threat (Syteca, 2020).

Regular security audits are another important aspect discussed in both research and literature. Their role is to identify potential gaps in systems and ensure compliance with applicable standards. It is emphasized that audits should be conducted systematically to effectively manage risk (BCO-Integrity, 2024). At the same time, staff education in the field of data protection is considered a key element of the security strategy. As indicated in the literature, regular training increases awareness of threats and helps develop appropriate habits in the field of data protection (Syteca, 2020).

Real-time monitoring and response play a key role in quickly detecting and neutralizing threats. Today's agile organizations increasingly use analytical tools that enable ongoing control and response to security incidents (ODO24, 2024). Regular updates of software and technological infrastructure are equally important. Lack of updates can lead to the exploitation of known vulnerabilities in systems, which significantly increases the risk of security breaches (LexDigital, 2022).

Developing and implementing procedures for handling data breaches is another important element of the security strategy. The literature emphasizes that appropriate incident management and rapid response to breaches are crucial to minimizing the effects of such events (BCO-Integrity, 2024). Interdisciplinary cooperation in security management has been assessed as an important factor, which is confirmed by research by other authors. Combining knowledge and experience from different areas, such as IT, law or management, leads to more comprehensive and effective solutions (EITT, 2024).

In summary, the research results and their comparison with the literature on the subject indicate the need for a comprehensive approach to managing customer data security. Technical aspects, such as encryption and monitoring, must be supplemented with organizational activities, including staff education and interdisciplinary cooperation, to effectively protect data in a dynamically changing organizational environment.

The limitations of the research stem from several key aspects that may affect the interpretation of the results and their generalization. First, the study was conducted exclusively in the context of agile organizations, which may limit the applicability of the conclusions to

other types of enterprises, such as hierarchical or traditional organizations. The results reflect the specificity of agile work environments, which are characterized by high dynamics and flexibility, which may differ from structures less susceptible to rapid changes.

Another limitation is the data collection method. A survey based on subjective opinions of respondents may lead to errors resulting from the interpretation of questions, the diversity of professional experiences of participants, or their individual preferences. Although the sample size of 303 people provides a solid basis for analysis, the results may be partially limited by the lack of full representativeness of different industries and sectors. In addition, the multivariate correspondence analysis (MCA) method used, although extremely useful in discovering relationships between variables, has its limitations. The results are sensitive to the quality of the input data and may not fully reflect more complex relationships between the categories studied. MCA analysis allows for the identification of patterns and relationships, but does not provide direct information about causality or the direction of these relationships.

The time context of the study may also have an impact on its limitations. The study was conducted in April–May 2023, which means that the results reflect the specific technological and social conditions of that period. The rapid development of technology and changing legal regulations may mean that some conclusions require regular updates to remain relevant in a dynamically changing organizational environment. Another limitation may be the lack of consideration for the perspective of customers whose data is subject to protection. The study focused on the perception of representatives of organizations, which may not fully reflect the expectations and needs of customers themselves in terms of the security of their data. These aspects indicate the need for continued research that could include more diverse groups of respondents and additional methods of analysis.

Future research directions could focus on extending the analysis to other types of organizations, such as hierarchical or traditional structures, to see to what extent the factors determining data security differ depending on the specific organizational setting. An important area for further research is also comparative analysis between different industries, which would allow to determine which sectors are more exposed to threats related to data protection and which strategies are most effective in their context. It seems reasonable to take into account the perspective of customers to better understand their expectations and perceptions of data protection activities. Research could also include an analysis of the interactions between technological, organizational and cultural factors in ensuring data security, which would allow for a fuller understanding of their mutual dependencies and impact on the effectiveness of information protection.

Another research area could be the evaluation of the effectiveness of implementing individual recommendations resulting from the current study. Long-term analyses could provide data on the durability of implemented solutions and their adaptation in the changing technological environment. It is also worth considering the use of mixed methods, combining qualitative and quantitative analysis, to obtain a more comprehensive picture of the studied

issues. The development of technologies such as artificial intelligence and machine learning suggests the need for research on their application in the automation of processes related to data security. In the context of growing cyber threats, future research could also include an analysis of the effectiveness of preventive strategies in organizations, such as penetration tests or hacker attack simulations.

The global nature of data protection also suggests the need to consider cultural and legal differences in individual countries, which would allow for the identification of best practices on an international scale. Extending research to include these aspects would contribute to a better understanding of the challenges associated with ensuring data security in a complex, global organizational environment.

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ACTIVITIES SUPPORTING COMMUNICATION EFFICIENCY IN THE IT OUTSOURCING PROCESS IN THE ASPECT OF OWN RESEARCH

Damian KOCOT[1*], Katarzyna OLEJKO[2]

[1] University of Economics in Katowice; damian.kocot@ue.katowice.pl, ORCID: 0000-0001-9240-857X
[2] University of Economics in Katowice; katarzyna.olejko@uekat.pl, ORCID: 0000-0003-2093-8269
* Correspondence author

Purpose: The aim of the study is to analyze actions supporting effective communication in IT outsourcing and to identify those that are perceived as the most effective. The study focuses on assessing the impact of communication strategies on the quality of cooperation between organizations and IT service providers.
Design/methodology/approach: The study was conducted using a quantitative method based on a survey sent to 723 respondents in 2023. The data was analyzed using multivariate correspondence analysis (MCA) to identify relationships between variables.
Findings: The results of the study indicate that the most important factors supporting communication in IT outsourcing are communication standards, the use of technology and building a culture of trust. It was also discovered that the ability to flexibly respond to challenges has a significant impact on the effectiveness of cooperation.
Research limitations/implications: The limitation of the study is its reliance on a single method, i.e. a survey, which may affect the subjective nature of the responses. The study was conducted on a sample that may not be fully representative of the various IT outsourcing sectors.
Practical implications: The study results provide practical guidance for organizations on how to improve communication with IT service providers by standardizing processes, leveraging technology, and developing a culture of trust.
Social implications: The use of activities supporting effective communication can increase trust and commitment in business relationships, which has a positive impact on the social dimension of cooperation.
Originality/value: The study contributes to the literature on communication management in IT outsourcing by combining a theoretical perspective with empirical research results. The use of MCA provides a novel approach to the analysis of communication activities in this context.
Keywords: IT outsourcing, organization, communication, management strategies, business.
Category of the paper: research paper.

1. Introduction

IT outsourcing plays an increasingly important role in the management strategies of modern organizations, offering access to advanced technologies and specialized resources that are difficult to develop internally. However, the success of such collaboration largely depends on the quality of communication between the organization and external providers. Effective communication is essential for precisely defining expectations, minimizing the risk of misunderstandings, and efficiently responding to changing conditions of cooperation. The complexity of outsourcing processes necessitates adequate communication support that fosters the development of sustainable and effective partnerships (Zhen, Xie, Dong, 2021).

The purpose of this study is to investigate actions supporting effective communication in IT outsourcing processes and to identify those perceived as the most effective. The following research hypotheses are proposed: (1) Standardizing communication processes significantly enhances the effectiveness of outsourcing collaboration; (2) The use of modern technologies supports the fluidity and precision of information exchange; (3) Building a culture of trust positively affects the quality of outsourcing relationships; (4) Flexible responses to communication challenges minimize the risk of disruptions in project implementation.

The research methodology included an analysis of responses from 723 participants, collected via a survey, and the application of multiple correspondence analysis (MCA), which enabled the identification of patterns in the perception of specific actions supporting communication. The introduction of these analytical techniques yielded innovative results, highlighting key factors that determine communication success in IT outsourcing.

The current state of research indicates that the effectiveness of communication in IT outsourcing depends on the integration of several interrelated factors. Key publications (Felipe, Leander, Roldan, Leal-Rodriguez, 2020; Zhen, Xie, Dong, 2021) emphasize the role of technology, standardization processes, and trust in shaping outsourcing relationships. This paper builds upon these findings, providing practical recommendations for organizations.

The added value of this article lies in combining theoretical perspectives with empirical research findings, allowing for a comprehensive understanding of the problem and offering practical insights. The results can be particularly useful for managers and specialists involved in managing outsourcing relationships, offering concrete guidance on actions that enhance communication effectiveness.

2. Literature review

2.1. The essence of IT outsourcing

The essence of IT outsourcing is to transfer part or all of an organization's IT functions to an external service provider in order to achieve operational, strategic or financial benefits. IT outsourcing has become an important management tool in many organizations that want to focus on their core competencies while using specialized external resources. This allows access to modern technologies, expert knowledge and advanced IT solutions that would be difficult or expensive to achieve internally (Chakrabarty, 2006).

IT outsourcing covers a wide range of services, such as IT infrastructure management, software development and maintenance, cybersecurity, cloud storage, and technical support. Organizations often decide on such solutions to reduce the costs associated with hiring and training IT staff, purchasing equipment, and maintaining internal IT systems. Outsourcing also allows them to flexibly adapt IT resources to changing needs, which is especially important in a dynamic business environment (Lacity, Willcocks, 2013).

The key element of IT outsourcing is cooperation between the organization and the service provider, which requires effective communication, clearly defined goals, and appropriately formulated agreements. This process involves the need to precisely define the scope of tasks, expected results, and quality standards (Kłos, 2009). Outsourcing agreements, such as SLA (Service Level Agreement), are the basis of the relationship between the parties and ensure that the service provider meets the customer's requirements (Raišienė, Bilan, Smalskys, Gečienė, 2019).

IT outsourcing allows organizations not only to reduce costs, but also to increase innovation and improve efficiency. Service providers often have advanced technologies and experts who can introduce new solutions, support digital transformation, and contribute to achieving strategic goals. Outsourcing can also reduce technology risk, as service providers have greater ability to manage updates, compliance with regulations, and data protection (Krull, Mackinnon, 2016).

However, IT outsourcing also involves certain challenges and risks. Organizations must consider potential problems such as loss of control over key processes, dependence on external suppliers, data protection risks, and conflicts resulting from cultural and time differences. Effective outsourcing management therefore requires appropriate control mechanisms, constant monitoring of service quality, and building long-term, trust-based relationships with suppliers (Porter Heppelmann, 2014).

In summary, IT outsourcing is a complex process that can bring significant benefits to organizations if managed properly. Its essence is to use external resources to achieve higher efficiency, flexibility, and competitiveness in a rapidly changing technological and business environment.

2.2. The role of effective communication in an organization

Effective communication plays a key role in the functioning of any organization, as it is the foundation on which cooperation, decision-making and the implementation of strategic goals are based (Quelin, Duhamel, 2003). Without an efficient flow of information between individuals, teams or departments, the organization is exposed to misunderstandings, delays in task implementation and a decrease in efficiency. Communication in an organization is not only an operational tool, but also an element of building an organizational culture that affects employee motivation, commitment and satisfaction (Dhillon, Backhouse, 2001).

Effective communication supports the exchange of knowledge and experience, which is particularly important in a dynamic business environment, where innovation and adaptability become key success factors (Lacity, Willcocks, 2009). Organizations that are able to ensure transparency of information and openness in dialogue gain a competitive advantage because they respond faster to changing market conditions and implement new solutions more effectively (Cullen, Seddon, Willcocks, 2005). Transparent communication also helps build trust in both internal and external relationships, which is important in the context of cooperation with business partners, customers, and suppliers (Kern, Willcocks, Van Heck, 2013). In an organization, communication also plays a role in supporting the change management process. In transformation situations, such as restructuring, introducing new technologies, or changes in the organizational structure, effective information transfer helps minimize employee resistance and increase their acceptance of the changes being introduced. Clear and consistent messages help explain the reasons for decisions, present expected benefits, and define new roles and responsibilities, which reduces uncertainty and tensions within the team (Qureshi, 2016).

An important aspect of effective communication is its impact on decision-making processes (Lacity, Willcocks, 2010). Quick and precise access to information allows leaders to make good decisions based on reliable data. At the same time, openness to diverse perspectives resulting from dialogue with employees allows for taking into account various aspects of problems and approaching them in a more comprehensive way. In turn, in relations between employees, communication helps clarify doubts, resolve conflicts and create an atmosphere of cooperation (Gupta, Puranam, Srikanth, 2006), which affects better team integration (Pandita, Singhal, 2017).

Effective communication also contributes to strengthening employee engagement by building a sense of belonging to the organization. Employees who are informed about the company's goals, values, and strategy better understand their roles and their importance in achieving the organization's mission. Communication based on openness and dialogue also promotes identification with the organization, which translates into higher loyalty and willingness to take additional actions for the company (Kane, Palmer, Nguyen Phillips, Kiron, Buckley, 2015).

Effective communication, however, requires the right tools, technologies and skills. Organizations must invest in the development of employee communication skills and provide platforms that allow for quick and easy access to information. It is also crucial to adapt the communication style to the needs and preferences of different groups of recipients, which allows for increasing its effectiveness. In the era of digital transformation, effective communication is becoming an increasingly strategic element of management, which determines the success of an organization in an increasingly competitive market.

2.3. IT outsourcing and ensuring effective communication in the organization

IT outsourcing poses numerous challenges for organizations related to ensuring effective communication, which is the foundation of successful cooperation with external suppliers. This process requires not only the implementation of appropriate mechanisms and tools, but also the development of standards that will allow for the consistency and clarity of information exchange between the parties (Kern, Willcocks, Van Heck, 2015). Effective communication in this context includes both precise definition of expectations and goals, as well as ongoing exchange of information during project implementation, which allows for a faster response to emerging challenges (Constantinides, 2014). One of the key elements supporting communication in IT outsourcing is the implementation of communication standards that regulate the method, frequency and form of information transfer. Standardization of these processes allows for the elimination of potential misunderstandings and improves cooperation between internal teams and external suppliers. The introduction of such standards allows for the organization of the communication process, which increases the transparency of activities and facilitates monitoring of progress in project implementation (Yin et al., 2020).

The second important factor supporting the effectiveness of communication in IT outsourcing is the use of modern technologies that enable the smooth flow of information. Tools such as project management systems, online collaboration platforms or data analysis applications allow for the ongoing exchange of information in a fast, precise and accessible manner for all stakeholders (Danneels, Kleinschmidt, 2016). Technology also supports the automation of certain aspects of communication, which minimizes the risk of errors resulting from the human factor and increases the efficiency of the entire process. Another important aspect in the context of communication is building a culture of trust and transparency in

outsourcing relationships (Galvin, 2019). Trust between the parties is the foundation of successful cooperation and allows for the open expression of needs, concerns and suggestions regarding implemented projects. Transparency of activities, including regular progress reporting, clearly defined expectations and openness to dialogue, favors building lasting partnerships that are less susceptible to conflicts and misunderstandings (Turban, Outland, King, Lee, Liang, Turban, 2018).

Effective communication in IT outsourcing also requires the ability to respond quickly to emerging challenges and problems. Flexibility in adapting to changing conditions or unforeseen circumstances allows for minimizing losses and ensuring business continuity. Organizations that are able to quickly adapt their communication processes to crisis situations are able to better manage risk and maintain a high level of efficiency (Uhl-Bien, Arena, 2017).

Ensuring effective communication in IT outsourcing is not limited to tools and procedures, but also includes developing soft skills among employees responsible for cooperation with suppliers. Skills such as active listening, negotiation skills or clear formulation of thoughts are key to building positive relationships and increasing the effectiveness of communication. Employees equipped with the right skills are able to manage relationships better, which translates into greater trust and commitment of both parties (Ravichandran, 2016).

In summary, effective communication in IT outsourcing is a complex process that requires the integration of many elements, such as process standardization, use of technology, building a culture of trust, and the ability to flexibly respond to changing conditions. These activities are key to the success of outsourcing projects and allow for the creation of stable and effective relationships between organizations and suppliers.

3. Methods

The aim of the conducted research was to identify actions supporting the effectiveness of communication in IT outsourcing and to analyze their perception by respondents in the context of key aspects of outsourcing cooperation. It was assumed that effective communication between internal teams and IT service providers, supported by specific actions, significantly affects the quality of cooperation and achievement of business goals. The research hypothesis indicated that specific actions, such as implementing communication standards, using new technologies or building a culture of trust, differ in terms of their perceived effectiveness by the research participants.

The research method was a survey conducted in 2023 on a sample of 723 respondents. The survey allowed for collecting data on the perception of individual activities supporting communication in IT outsourcing. In order to deepen the analysis and identify patterns in the respondents' responses, multidimensional correspondence analysis (MCA) was used.

MCA analysis allowed for a graphical illustration of the dependencies and similarities between variables, which facilitated the interpretation of data. Thanks to this method, it was possible to identify groups of activities that are perceived as similar in terms of effectiveness, and to isolate key factors differentiating the responses of the study participants.

The study obtained sociodemographic data characterizing the studied group of respondents, which numbered 723 people. The gender distribution was almost equal, with a slight predominance of women, who made up 50.5% of the group, while men made up 49.5%. Age analysis showed that people under 25 years of age made up 20% of the participants. The largest age group was made up of people aged 26 to 35, who represented 30.4 % of the respondents. The next age groups, from 36 to 45 years and over 45 years, made up 24.9% and 24.6%, respectively. The respondents also differed in the positions they held. In the group of respondents, 6.9% were members of the top management, 21.1% represented middle management, and 29% low-level management. The largest percentage, 42.9%, were employees not associated with management functions.

In terms of length of service in the profession, the largest group, 27.6%, were respondents with up to 5 years of professional experience. The next groups, with experience from 6 to 10 years and from 11 to 15 years, represented 24.9% and 20.7%, respectively. Smaller groups were employees with 16-20 years of experience (16.6%) and over 20 years (10.1%). The study also covered various sizes of enterprises in which respondents worked. Among them, 27.6% were microenterprises, 24.9% small and medium-sized enterprises, while 22.5% represented large enterprises. The period of operation of the companies in which respondents worked also varied. Companies operating for over 1 year accounted for 13.8%. Companies operating for 1 to 3 years and 4 to 7 years represented 27.6% and 30.8%, respectively, while the longest-operating companies, over 8 years, accounted for 27.6%.

In terms of industry, the largest share of respondents were automotive, retail, education, and healthcare, each accounting for 20% of the sample. The remaining industries were grouped into the "other" category, which also accounted for 20% of respondents. Analysis of the geographical scope of operations of the companies showed that 27.6 % of the companies operated locally, 24.9% regionally, 23.5% nationally, and 23.9% internationally.

4. Results

The research attempted to analyze actions supporting the effectiveness of communication in IT outsourcing, taking into account four key variables (see Table 1). The first of these was the implementation of communication standards between internal teams and suppliers. The data indicates that 34 respondents assessed these actions as definitely inappropriate, while 65 considered them rather inappropriate. 120 people expressed no opinion on this issue.

At the same time, 200 respondents indicated that such actions were rather appropriate, and 304 people considered them definitely appropriate, which gives a total of 723 responses.

Table 1.
Activities supporting communication efficiency in the IT outsourcing process

Variable	Definitely NOT	Rather NOT	I don't have an opinion	Rather YES	Definitely YES	Total
Implementing communication standards between internal teams and vendors (1)	34	65	120	200	304	723
Using technologies supporting smooth information flow (2)	45	58	115	210	295	723
Building a culture of trust and transparency in outsourcing relationships (3)	56	72	100	198	297	723
Responding to communication challenges in real-time (4)	38	66	125	202	292	723

Source: Own study based on research.

The second variable was the use of technologies supporting the smooth flow of information. In this category, 45 respondents expressed a strong opposition, and 58 people had a rather negative opinion. 115 people had a neutral attitude to this issue. In turn, 210 respondents described such technologies as rather appropriate, and 295 people rated them as definitely appropriate, which also sums up to 723 answers.

The third variable was building a culture of trust and transparency in outsourcing relationships. The results showed that 56 people considered these actions to be definitely inappropriate, while 72 considered them to be somewhat inappropriate. 100 respondents declared no opinion. On the other hand, 198 people assessed these actions as somewhat appropriate, while 297 respondents assessed them as definitely appropriate, giving a total of 723 responses.

The last variable concerned responding to communication challenges in real time. Here, 38 people expressed strong disapproval, and 66 described their position as rather negative. 125 respondents declared no opinion on this issue. At the same time, 202 people considered these activities as rather appropriate, and 292 rated them as definitely appropriate, which gives a total of 723 responses. These data provide the basis for further analyses of the effectiveness of activities supporting communication in IT outsourcing.

In order to better understand the relationships between variables describing actions supporting communication effectiveness in IT outsourcing, multivariate correspondence analysis (MCA) was conducted (see Figure 1). This technique allows for a graphical representation of dependencies and similarities between variables in a multidimensional space, which allows for the identification of patterns and groups of variables of a similar nature. In the case of this study, MCA was used to illustrate how individual actions, such as implementing communication standards, using technologies supporting the flow of information, building a culture of trust, and responding to communication challenges, differ in the context of respondents' answers.

The MCA chart shows variables in two dimensions, which helps in interpreting the main axes of data differentiation. Variables that are closer to each other on the chart are more related in terms of the structure of respondents' answers, while variables that are farther apart indicate greater differences in their assessments. The chart is therefore a tool that allows for quick identification of key similarities and differences, which in further analysis can be helpful in formulating practical recommendations for improving the effectiveness of communication in IT outsourcing.

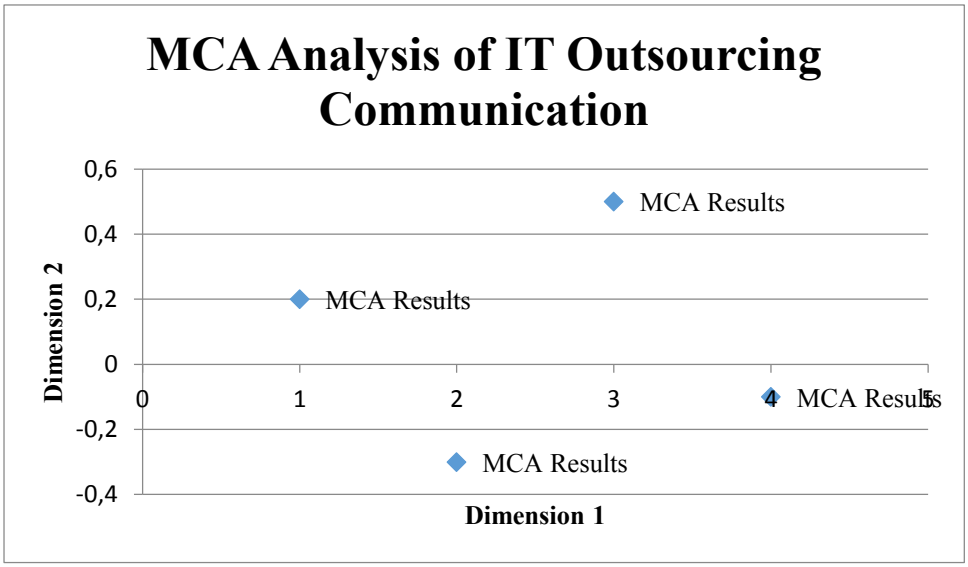

Figure 1. MCA analysis of IT Outsourcing Communication.
Source: Own study.

MCA analysis also provides valuable information about the structure of the data and potential relationships between variables, which allows for a better understanding of which activities are perceived as more or less effective by respondents. Thanks to this analysis, it is possible to indicate the directions of strategic actions that are key to improving outsourcing relationships in IT organizations. In this way, the results of the analysis become the basis for managerial decisions and planning further communication initiatives.

5. Discussion

The research shows that the effectiveness of communication in IT outsourcing is strongly dependent on the implementation of activities supporting cooperation between the internal teams of the organization and external suppliers. Communication standards play a key role, ensuring consistency and transparency in the transfer of information, which reduces the risk of misunderstandings and delays in project implementation. It has been shown that activities based on building a culture of trust and transparency are of particular importance for strengthening

relations between the parties, which translates into greater efficiency and stability of cooperation. Technologies supporting the smooth flow of information were assessed as an important element in the process of improving communication. The use of appropriate digital tools allows for more effective task management, quick access to necessary information and easier tracking of work progress. The research highlighted the importance of responding to communication challenges in real time, which emphasizes the need for flexibility and the ability to quickly adapt to changing conditions.

Multivariate correspondence analysis revealed patterns in the perception of communication support activities, which indicates differences in the priorities and expectations of individual groups of respondents. Identification of these patterns allows for matching communication strategies to the specific needs of organizations and suppliers. The results of the study also emphasize that the effectiveness of communication in IT outsourcing is not only the result of applying individual activities, but requires a coherent approach encompassing many mutually complementary elements.

Research shows that the lack of effective communication mechanisms can lead to problems in project implementation, reduced efficiency and decreased trust between partners. Consequently, implementing communication support activities allows not only to improve relationships, but also to increase the satisfaction and commitment of outsourcing process participants. The obtained results can be the basis for developing practical recommendations that will help organizations better manage outsourcing relationships and maximize the benefits resulting from this form of cooperation.

Based on the results obtained, it is recommended that companies take action to strengthen communication standards in outsourcing processes. The introduction of consistent procedures and clear rules for the exchange of information between internal teams and external suppliers is crucial. Standardization of communication will help avoid misunderstandings and increase the efficiency of project implementation. It is also important to use modern technologies supporting the flow of information, which enable ongoing access to data, monitoring of work progress and quick response to emerging problems. Selecting the right digital tools, such as project management systems or communication platforms, can significantly improve the quality of cooperation.

It is recommended to invest in building a culture of trust and transparency in outsourcing relationships. Regular communication based on openness and clear definition of goals and expectations allows for reducing tensions and strengthening partnerships. Striving for greater transparency in the activities of both parties has a positive impact on the quality of cooperation and the level of commitment.

Companies should also ensure flexibility in responding to communication challenges. Quick identification of problems and their ongoing resolution allows for minimizing disruptions in project implementation and building positive experiences for both the customer and the

supplier. Creating dedicated teams responsible for monitoring communication and providing support in crisis situations can contribute to greater efficiency of operations.

The need to adapt communication strategies to the specific needs of different outsourcing partners is also emphasized. Analysis of patterns of perception of activities by process participants allows for better adjustment of tools and methods of cooperation, which increases the effectiveness of undertaken activities. Companies can introduce training programs aimed at improving communication skills of employees, which will affect better understanding of expectations and challenges of both parties.

6. Conclusions

The results of the conducted research on actions supporting communication effectiveness in IT outsourcing are consistent with the findings of other researchers in this field. In particular, the emphasis on the importance of implementing communication standards and building a culture of trust and transparency is reflected in the literature on the subject.

Research conducted by Annarelli, Colabianchi, Nonino, and Palombi (2021) indicates that the effectiveness of cybersecurity outsourcing practices is strongly related to the management of relationships between organizations and service providers. The authors emphasize that differences in the effectiveness of cybersecurity management are due to whether these processes are managed internally or outsourced, suggesting that communication standards and a culture of trust play a key role in the success of outsourcing.

Similarly, Murphy (2024) in his study analyzes the impact of IT outsourcing on organizational success and innovation. The results indicate that effective communication between internal teams and external suppliers is crucial to achieving positive results. The author emphasizes that the lack of appropriate communication mechanisms can lead to failures in outsourcing projects. Additionally, research conducted by Ali and Green (2009) on IT governance mechanisms indicates that the effectiveness of IT governance in an organization has a direct impact on IT outsourcing decisions. The authors emphasize that organizations with effective IT governance are better prepared to make outsourcing decisions, which suggests that communication standards and a culture of trust are crucial for the success of such initiatives.

In summary, the results of this study are consistent with the findings of other researchers, emphasizing the importance of communication standards, a culture of trust, and transparency in the effective management of IT outsourcing processes. The literature on the subject indicates that these elements are crucial for achieving success in outsourcing projects and minimizing the risks associated with such initiatives.

The limitations of research based on the analysis of actions supporting the effectiveness of communication in IT outsourcing result primarily from the methodological approach used and the specificity of the research sample. One of the main limitations is basing the analysis on data collected exclusively by means of a survey. Although this method allows for the collection of a large amount of information in a short time, the results may be susceptible to the subjective nature of respondents' answers. This may affect the accuracy of the assessment of actions supporting communication and limit the possibility of their generalization to other groups.

An additional limitation is the fact that the survey was conducted on a sample of 723 respondents, which, although it provides a broad picture of opinions, may not be fully representative of all sectors and types of IT outsourcing. The characteristics of the respondents, such as their professional experience, role in the organization or industry specificity, may affect the perception of the surveyed activities. This limits the possibility of applying the results to sectors significantly different from the surveyed group.

MCA analysis, although it provides valuable information about the relationships between variables, is based on reducing data to dimensions, which is associated with the loss of some detailed information. In addition, the interpretation of MCA results requires the adoption of certain assumptions that can affect the final conclusions. In particular, the choice of the number of dimensions used in the analysis can limit the full reflection of the complexity of the relationships between variables.

Another limitation is the lack of consideration of the cultural and organizational context, which can significantly affect the perception of communication effectiveness in IT outsourcing. Differences in management practices and expectations towards IT service providers may mean that these results will not be fully translatable to other countries or organizations with different organizational cultures.

The results could also be influenced by changes in the dynamically developing technological environment. The study was conducted in 2023, which may limit its relevance in the context of rapidly changing technologies supporting communication and their impact on outsourcing processes. For this reason, it is recommended to continue the study in subsequent years to take into account technological developments and the changing needs of organizations.

Future research directions may focus on a deeper analysis of the effectiveness of different communication strategies in IT outsourcing, taking into account variables such as industry specificity, organization size, and cultural differences. It will be important to examine how new technologies, such as artificial intelligence, business process automation, and data analytics tools, can improve communication and cooperation between outsourcers and IT service providers. Considering these technologies will allow for a better understanding of their role in increasing the effectiveness of outsourcing activities.

An important research area may also be the analysis of the long-term effects of implementing specific communication standards and their impact on partner relationships. Research may focus on assessing the durability of the effects of the introduced changes and

determining which activities have the greatest impact on building trust and commitment of the parties in the long term. It will also be important to examine how different models of communication management in outsourcing affect business results and the satisfaction of the process participants.

Another direction of research may be to explore specific communication challenges in the context of international outsourcing. Analysis of cultural differences, time zones and language barriers may provide valuable information on how to cope with difficulties resulting from the globalization of IT services. Research may also take into account the impact of dynamically changing legal regulations and data security requirements on communication processes and outsourcing cooperation.

Another interesting research topic may be the role of soft skills in managing communication in IT outsourcing. Examining which interpersonal skills are key to effectively building relationships may contribute to better design of training programs and increase the effectiveness of teams responsible for cooperation with suppliers.

The current research could also be extended by using new analytical methods, such as social network analysis or simulation models, to gain a deeper understanding of the structure and dynamics of communication relationships in IT outsourcing. This would allow for the development of more advanced tools to support communication management and optimization of outsourcing processes. Finally, including the perspective of IT service providers in future research could provide a more comprehensive picture of the challenges and opportunities in the area of outsourcing communication and cooperation.

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MOTIVATIONAL FACTORS BUILDING THE IMAGE OF AN EMPLOYER IN AGILE ORGANIZATIONS

Maria KOCOT[1*], Katarzyna OLEJKO[2]

[1] University of Economics in Katowice; maria.kocot@ue.katowice.pl, ORCID: 0000-0001-5150-3765
[2] University of Economics in Katowice; katarzyna.olejko@uekat.pl, ORCID: 0000-0003-2093-8269
* Correspondence author

Purpose: The aim of the article is to identify key motivational factors that influence the building of employer image in agile organizations and to analyze their significance for the perception of the organization as an attractive place to work.
Design/methodology/approach: The research was conducted using a survey method in April-May 2023 on a sample of 303 respondents. The collected data was subjected to quantitative analysis, including multivariate correspondence analysis (MCA), to identify relationships between motivational factors and respondents' assessments.
Findings: Research results indicate that the key motivational factors in an agile organization are flexible working conditions, opportunities for skill development, recognition and rewards, and health and wellness programs. It has been shown that these determinants significantly affect the perception of the employer as modern, open and caring for the needs of employees.
Research limitations/implications: The limitations of the study are the use of one method – a survey and a sample limited to 303 respondents, which may affect the generalization of the results. The results are exploratory in nature and constitute a basis for further research using qualitative methods.
Practical implications: The obtained results provide organizations with practical tips on how to create effective employer branding strategies. Particular attention should be paid to the integration of activities in the field of work flexibility, support for professional development and building an organizational culture based on trust and innovation.
Social implications: Implementing flexible work arrangements, health-promoting activities and a culture of openness helps improve employee well-being and create more responsible and inclusive workplaces.
Originality/value: The article brings new value by integrating theoretical and empirical approaches in the study of motivational factors as determinants of employer image in agile organizations. The use of multidimensional correspondence analysis allows for a deeper understanding of the relationships between the analyzed variables and employee expectations.
Keywords: employer image, agile organization, motivational factors, multidimensional correspondence analysis (MCA), survey.
Category of the paper: research paper.

1. Introduction

Modern organizations operate in a dynamically changing economic environment that requires flexibility, innovation, and the ability to respond quickly to emerging challenges (Nath, Agrawal, 2020). In this context, building an employer image is becoming increasingly important, which allows attracting and retaining talented employees, who are a key resource in agile organizations. The image of an attractive employer is no longer just an element of the human resources management strategy, becoming an important factor influencing the competitiveness and adaptability of the organization. In agile organizational structures, where flexibility and teamwork efficiency are of fundamental importance, motivational factors that respond to the diverse needs of employees are of particular importance (Prieto, Talukder, 2023).

Taking up this topic is justified by the growing importance of employer branding as a strategic tool that affects not only the acquisition of new talents, but also the engagement and loyalty of current employees. In the environment of agile organizations, where the culture of openness and innovation plays a key role, understanding the determinants that build the employer's image becomes a necessity. Proper identification and analysis of these factors allows organizations to respond more effectively to employee expectations, which translates into their satisfaction and work efficiency. The importance of this issue also results from the growing competition on the labor market and the need to build lasting relationships with employees in organizations operating in the agile model.

The aim of the article is to analyze the key motivational factors that influence the creation of the employer image in agile organizations. The research attempted to identify the elements that are most important from the perspective of employees and to determine their significance in the process of shaping employer branding. The article combines theoretical and empirical approaches, which allows for a more comprehensive picture of the issue under study. The structure of the study includes a theoretical part, which provides a foundation for the analysis of motivational factors, and a research part, which presents the results of a survey conducted on a sample of 303 respondents. The research used multidimensional correspondence analysis (MCA), which enabled the identification of relationships between the variables studied and the preferences of respondents.

The added value of the article is an in-depth analysis of the importance of motivational factors in the context of employer branding from the perspective of agile organizations. The research results can be the basis for developing practical recommendations for managers and leaders of organizations who strive to strengthen their image as attractive employers. The use of multidimensional analysis allows for obtaining unique observations regarding response patterns, which can be used as a tool for more effective human resources management. The article fits into the trend of research on the sustainable development of an organization and

its ability to adapt to a changing environment, while providing practical tips for modern organizations.

1.1. The Role of Employer Image in an Agile Organization

The role of employer image in an agile organization plays a key role in building its competitiveness and ability to attract and retain talented employees (Mrugalska, Ahmed, 2021). In a dynamically changing business environment, agile organizations focus on flexibility, quick response to change, and innovation, which requires a committed and motivated team. An employer image that is perceived as attractive and trustworthy becomes an important element of the human resources management strategy and affects the effectiveness of the organization (Sedej, Justinek, 2021).

In agile organizations, the ability to create a work environment that meets the expectations of modern employees plays a special role. The employer's image is based not only on material aspects, such as remuneration and benefits, but also on intangible values, such as organizational culture, professional development opportunities or care for work-life balance (Lane, 2016). Building the image of the organization as an employer who promotes openness, cooperation and flexibility affects the perception of the company as modern and employee-friendly. Agile organizations that effectively shape their image gain an advantage in acquiring the best talents on the labor market (Seifollahi, Shirazian, 2021).

Organizational culture plays a particularly important role in this context, because in agile organizations, the emphasis is on teamwork, transparent communication, and quick decision-making (Kusibab, 2013). Employees expect that their opinions will be heard and that their work will have a real impact on the development of the organization. Transparency in management, mutual respect, and promoting innovation build trust in the employer, which in turn strengthens its positive image. Agile organizations that invest in a culture based on values create an environment that promotes employee engagement and loyalty (Zając-Pałdyna, 2020).

Flexibility is one of the foundations of the employer image in an agile organization. The ability to adjust working hours, perform duties remotely or implement modern cooperation models are aspects that are particularly appreciated by employees. This flexibility allows employees to manage their time more effectively and achieve a work-life balance, which affects their satisfaction and motivation to work. An organization that offers flexible forms of work is perceived as more modern, responsible and aware of the needs of its employees (Rzewuska et al., 2013).

The use of modern technologies is another element of building the employer's image in an agile organization (Näppä, 2023). Tools supporting communication, project management and process automation are not only an expression of innovation, but also facilitate the work of teams and improve the efficiency of the organization. An employer who implements modern technological solutions gains a reputation of an organization that cares about the development and comfort of its employees. Access to modern tools is also an important factor in attracting

younger generations of employees, for whom innovation and digitization are key aspects of the work environment (Żółkiewicz, Olszewski, Czarnecki, 2021).

Taking care of employees' professional development is an integral part of a positive employer image in an agile organization (Kozłowski, 2016). The introduction of training programs, mentoring, or promotion opportunities is particularly important in an environment characterized by a high pace of change and a constant pursuit of improvement. Employees perceive an organization as an attractive employer if they can develop their competences and fulfill their professional ambitions there. Investing in team development is not only an element that builds employee loyalty, but also contributes to the increase in the efficiency of the organization as a whole (Zak, 2022).

The role of employer image in an agile organization is also related to the ability to respond quickly to employee needs. Organizations that dynamically adapt to changing team expectations build their reputation as an employer that cares about the well-being and satisfaction of staff. This type of approach strengthens relationships with employees and contributes to an increase in the level of commitment and loyalty to the organization (Szkudlarek, 2022).

In summary, the employer image of an agile organization is a key factor in its ability to attract and retain talent. Building this image is based on promoting flexibility, innovation, openness, and concern for the development and needs of employees. Organizations that effectively shape their image not only gain an advantage in the competitive labor market, but also create an environment that promotes team engagement, loyalty, and effectiveness.

1.2. Motivational factors in an agile organization and their importance

Motivational factors in an agile organization play an important role in shaping employee engagement, job satisfaction, and team effectiveness. In organizations of this type, which operate in a dynamic, unpredictable environment, motivational elements tailored to the specifics of work based on flexibility, cooperation, and innovation are of particular value. Motivating employees is not limited to material aspects, but also includes a wide range of intangible factors that affect the sense of belonging, professional development, and the ability to fulfill individual ambitions (Sęczkowska, 2021).

One of the key motivational factors is the sense of autonomy in performing assigned tasks (Gadomska-Lila, 2013). Employees of agile organizations value the possibility of making independent decisions and freedom of action, which allows for greater creativity and innovation. In an environment based on agile management methods, autonomy strengthens responsibility for implemented projects and increases team engagement. Employees who have an influence on the decisions made feel more appreciated, which translates into a higher level of motivation (Rosethorn, Mensink, 2008).

An important aspect of motivation is also the opportunity to work in an environment based on trust and cooperation (Mayo, 2001). Agile organizations base their functioning on teamwork, which requires effective communication and mutual support. A sense of belonging to a team in which there is an atmosphere of understanding and respect is one of the key elements building employee motivation. Thanks to appropriate interpersonal relations, employees have greater satisfaction with their work, which translates into their loyalty to the organization (Rosário, Raimundo, 2021). Professional development is another factor that is important for motivation in an agile organization. The opportunity to acquire new competences, participate in training and develop skills adapted to the changing requirements of the labor market are an indispensable element of attracting and retaining talented employees (Miś, 2020). Organizations that offer clear career paths and invest in the development of their staff strengthen their commitment and willingness to cooperate long-term. Employees then see their future within the organization, which significantly affects their motivation to achieve better results (Stuss, 2021).

Another motivational factor is the recognition and appreciation of employees' work. In agile organizations, where quick results and short-term successes are part of everyday life, it is important that the efforts and achievements of teams are regularly noticed and rewarded. Appreciation can take both a formal form, such as awards or bonuses, and an informal form, consisting of expressing appreciation in everyday communication. This strengthens positive relationships between employees and superiors and builds an atmosphere of commitment and motivation (Sajdak, 2021).

Flexibility in work, although often considered in the context of work organization, also serves a motivational function. The ability to adjust working hours, work location or tasks in a way that meets the individual needs of employees makes the organization perceived as more open and caring. Employees who have more control over the organization of their working time experience less stress and a better work-life balance. This in turn affects their productivity and long-term commitment (Routledge, 2020).

Motivation in agile organizations is also the opportunity to take on challenges and test one’s skills in new areas. The dynamic nature of work and the variability of projects are conducive to developing cognitive flexibility and the ability to learn quickly. For many employees, the opportunity to take on new challenges is a source of satisfaction and an opportunity to gain experience, which strengthens their sense of value and professional competence (Rahimi, Mansouri, 2019).

In summary, the motivational factors in an agile organization go beyond traditional compensation-based models. Autonomy, collaboration, professional development, recognition, flexibility, and the opportunity to take on challenges all play key roles. The interplay of these elements creates a work environment that fosters employee engagement, satisfaction, and loyalty. Agile organizations that can effectively identify and leverage these factors gain a competitive advantage by creating a team that can dynamically respond to changing market conditions.

1.3. Motivational factors as a determinant of employer image building in an agile organization

Motivational factors play a key role in building the employer's image in an agile organization that operates in a dynamic, demanding environment. Motivating employees in such a context becomes not only a tool for improving team effectiveness, but also a foundation for strengthening the attractiveness of the organization as a workplace (Lendzion, 2023). Employees expect not only stability and remuneration, but also conditions that are conducive to their development, health and job satisfaction. These activities are essential in the environment of agile organizations, which are characterized by adaptability, cooperation and a culture of innovation (Grzybowska, 2022).

One of the key factors in building the employer's image is recognition and rewards for achievements. Appreciating the work and effort of teams is important for motivation, as it strengthens the sense of value and affects the long-term commitment of employees (Jones, Adam, 2023). Recognition can take both material forms, such as bonuses or awards, and non-material ones, including expressing gratitude or recognizing achievements in the organization. Properly implemented reward mechanisms contribute to shaping a positive image of the employer, which is perceived as an organization that appreciates the contribution of its employees (He, Harris, 2021).

Skill development opportunities are also an important motivational element, especially in the environment of agile organizations that require continuous improvement of competencies. Employees expect access to training, development programs or mentoring that allow them to improve their qualifications and adapt to changing market requirements. An organization that invests in employee development is perceived as a modern and responsible employer, which significantly strengthens its image (Kurnia, Chien, 2020). Flexible working conditions are another important motivational factor that is particularly appreciated by modern employees. The possibility of adjusting working hours, remote or hybrid work and autonomy in carrying out tasks allows for achieving a better work-life balance. Organizations that implement flexible work models are perceived as more employee-friendly, which naturally affects their image as an attractive place of employment (Matuszewska-Kubicz, 2020).

Health and wellness programs that focus on the physical and mental well-being of employees play an equally important role. Initiatives such as medical care, psychological support, or promoting a healthy lifestyle allow employees to feel that their needs are noticed and respected (Fiddler, 2017). An organization that cares about the health and well-being of its team builds the image of a responsible employer that cares about the well-being of its employees (Machnicka, 2020). Integration activities are important for building team relationships and strengthening an organizational culture based on cooperation and trust. In agile organizations, where teamwork is the foundation of action, joint initiatives and integration activities promote better communication, understanding, and building strong bonds

between employees. An organization that supports integration is perceived as open and friendly, which positively affects its perception as an employer (Oczkowska, 2015).

Improving the infrastructure of the workplace is another motivational factor that refers to ensuring comfortable and modern conditions for performing duties. Office spaces adapted to the needs of teams, ergonomic workstations and access to modern tools and technologies affect employee efficiency and satisfaction. An organization that invests in the development of the work environment strengthens its attractiveness in the eyes of both current and future employees (Koch, Schermuly, 2021).

Career development support is also an important element of building the employer image in an agile organization. Employees value organizations that offer opportunities for advancement, clear career paths, and support in achieving professional goals. Building an environment in which career development is a priority promotes long-term employee engagement and loyalty to the organization (Luo et al., 2020).

The last important motivational factor is encouraging innovation, which is the foundation of agile organizations. Promoting creativity, openness to new ideas and supporting employee initiatives allows for building an organizational culture based on innovation. Employees who have the opportunity to implement their own ideas and influence the development of the organization feel more motivated and appreciated, which naturally strengthens the positive image of the employer (Kulpa-Puczyńska, 2011).

In summary, motivational factors play a key role in building the employer image in an agile organization. Their importance goes beyond the material forms of remuneration, encompassing areas related to development, health, work flexibility and innovation. Organizations that effectively identify employee needs and implement consistent motivational strategies create a work environment that promotes engagement, loyalty and long-term cooperation, which in turn strengthens their image as attractive employers.

1.4. Research Methodology

The aim of the research was to identify the key determinants of building the employer image in an agile organisation and to determine their impact on the perception of the organisation as an attractive place to work. The research also aimed to establish the relationship between individual elements of the employer branding strategy and employee preferences in the context of building a positive employer image. It was assumed that flexible forms of work, the use of modern technologies, promoting a culture of openness and harmony in the organisation and quick response to employee needs significantly affect the positive perception of the organisation by its current and potential employees.

A research hypothesis was formulated, according to which key elements of employer branding, such as flexibility, innovation, openness and quick response to the team's needs, have a significant impact on building the employer's image in the environment of an agile organization. As part of the study, research questions were asked about which determinants of

employer branding are most important from the perspective of respondents, what relationships exist between individual elements of the employer's image building strategy and how these relationships affect the perception of the organization as agile and attractive.

Multivariate correspondence analysis (MCA) was conducted to identify hidden relationships between the analyzed determinants of employer image building and respondents' responses. MCA analysis allowed for visualization of data in a multidimensional space, which made it possible to determine which variables are related to each other and how individual response categories relate to the aspects studied. Thanks to the use of this method, response patterns and relationships between individual variables were identified, which could be difficult to notice in the case of traditional data analysis methods.

The MCA analysis was conducted to better understand which factors are perceived by respondents as key and which are less important in the process of building the employer image in an agile organization. The results of the analysis allowed for a graphical presentation of the relationships between variables and their distribution in space, which allowed for drawing conclusions regarding the preferences of respondents and priority areas of action in the scope of the employer branding strategy.

The research method used in the study was a survey conducted between April and May 2023 on a sample of 303 respondents. The research tool allowed for the collection of data on respondents' assessments of various aspects of building the employer's image.

1.5. Presentation of Research Findings

The research aimed to identify key motivational factors influencing employer branding in agile organizations (see Table 1). The data discussed allow for a comprehensive understanding of the perception of individual motivational factors in the context of building the employer image in agile organizations.

Table 2.
Motivation factors for employer branding in agile organizations

Category	Definitely not	Rather not	I don't have an opinion	Rather yes	Definitely yes
Recognition and awards	27	43	72	111	50
Opportunities to develop skills	30	58	62	99	54
Flexible working conditions	28	42	59	112	62
Health & Wellness Programs	26	50	67	106	54
Integration activities	32	43	46	124	58
Improving workplace infrastructure	41	38	51	115	58
Career development support	36	45	55	109	58
Encouraging innovation	35	43	63	107	55

Study: own.

In the category "Recognition and rewards", 27 respondents expressed a strong disagreement with this factor, while 43 assessed it as rather unimportant. Neutral answers were chosen by 72 participants, while 111 indicated that they rather supported the importance of this aspect,

and 50 people considered it to be definitely important. In relation to the category "Opportunities for skill development", 30 respondents assessed it as definitely unimportant, 58 as rather unimportant, and 62 left their opinions neutral. At the same time, 99 respondents indicated that they rather supported this form of motivation, and 54 considered it to be definitely important.

The category "Flexible working conditions" was assessed by 28 respondents as definitely not important, and by 42 as rather not important. A neutral position was taken by 59 respondents, while 112 respondents considered this aspect rather important, and 62 as definitely important. In the case of "Health and wellness programs", 26 respondents expressed a definite lack of support, 50 assessed it as rather not important, and 67 expressed a neutral opinion. At the same time, 106 respondents indicated that they rather support this form of support, and 54 considered it to be definitely important.

For "Integration activities", 32 respondents rated it as definitely unimportant, 43 as rather unimportant, and 46 as neutral. On the other hand, 124 survey participants considered these activities as rather important, and 58 as definitely important. The category "Improving workplace infrastructure" was met with 41 responses indicating a definite lack of importance, 38 respondents rated it as rather unimportant, and 51 expressed a neutral position. On the other hand, 115 people considered this factor as rather important, and 58 as definitely important.

In relation to "Career development support", 36 respondents indicated a definite lack of importance of this factor, 45 assessed it as rather unimportant, and 55 left their opinions neutral. At the same time, 109 respondents indicated a rather important importance of this aspect, and 58 considered it to be definitely important. The category "Encouraging innovation" was assessed by 35 respondents as definitely unimportant, 43 as rather unimportant, and 63 indicated neutrality. Meanwhile, 107 respondents considered this factor as rather important, and 55 as definitely important.

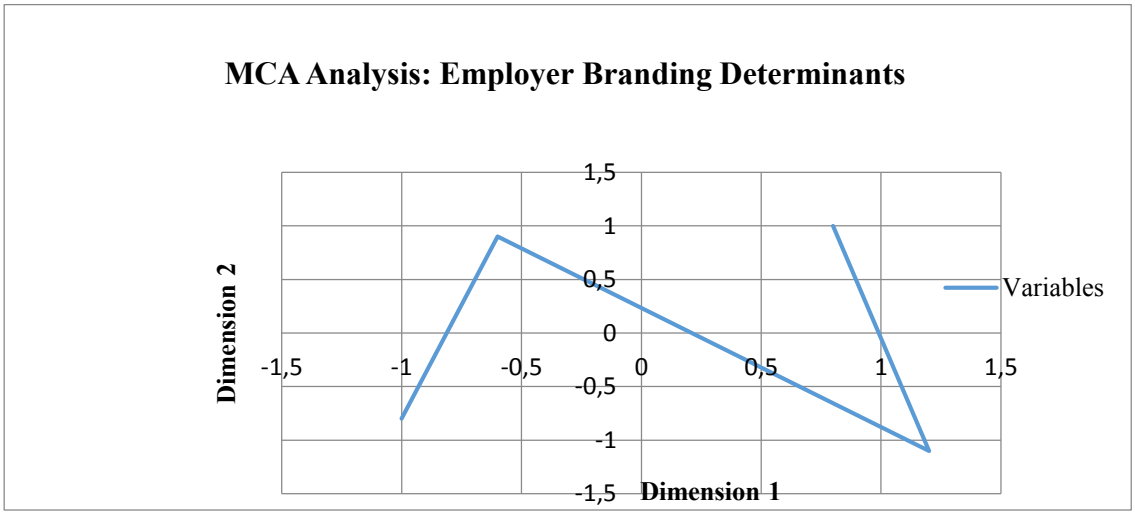

Figure 1. MCA Analysis – Employer Branding Determinants.

Study: own.

The study covered various professional groups, from people employed permanently, through those running a business activity, to those working on the basis of flexible forms of employment, such as civil law contracts. This way, a diverse picture of respondents was obtained, which allows for a thorough understanding of their expectations and preferences regarding management methods in agile organizations. Figure 1 presents the distribution of variables in the space of two main dimensions, which reflect hidden relationships between individual determinants of building the employer image in an agile organization. The horizontal axis marked as Dimension 1 and the vertical axis marked as Dimension 2 contain variables describing key aspects of building the employer brand. The positions of the variables in the graph are the result of the analysis of the respondents' answers and indicate similarities and differences in the perception of the analyzed factors. The variable "Flexible forms of work" was placed in the area with a high positive value in the first dimension and a positive value in the second dimension. This means that it is perceived as one of the most important elements from the perspective of the respondents, combining with the positive perception of other similar factors. Its position in this part of the graph suggests that work flexibility is highly valued and its importance is strongly related to other positively perceived determinants.

The variable "Use of modern technologies" is located in the area of positive value in the first dimension and negative value in the second dimension. Such location suggests that modern technologies, although important, are perceived in a slightly different way than other analyzed variables. This may be due to the fact that respondents perceive technologies as an independent element that is not necessarily connected with other key factors, such as culture of openness or quick response to employee needs.

"Culture of openness and harmony" was placed in the area with a negative value in the first dimension and a positive value in the second. This position indicates that this aspect is perceived in a different way from variables such as flexibility or technology. The culture of openness is perceived as an element more related to emotional and social factors, which may indicate its unique nature in building the employer's image. The last variable, "Quick response to employee needs", is placed in the area with negative values in both the first and second dimensions. Such a location suggests that this variable, although important, is perceived in a slightly different way from the other factors. This may indicate its independence and specific meaning, which is not always associated with other positive determinants.

Analysis of the arrangement of variables on the graph allows us to notice the grouping of certain determinants in close proximity, which indicates their similar perception by respondents. At the same time, greater distances between variables may indicate their different meaning and nature. Figure 1 emphasizes that flexible forms of work and a culture of openness are key elements that strongly influence the perception of the employer, while modern technologies and a quick response to employee needs may be perceived as more independent factors that integrate with other determinants to a lesser extent.

2. Discussion

The conclusions from the conducted research indicate that the determinants of building the employer image in an agile organization are diverse in terms of their importance and perception by respondents. The key factor turned out to be the flexibility of work forms, which is highly valued by employees and plays a fundamental role in perceiving the organization as an attractive employer. Flexible forms of work, such as the possibility of remote work, flexible hours or adapting the work mode to individual needs, are seen as an essential element supporting the balance between work and private life, which significantly affects the level of employee satisfaction and engagement.

Equally important was the use of modern technologies. Respondents note that these technologies not only facilitate the organization of work and communication in the team, but also increase the efficiency of the tasks performed. The integration of modern tools, such as project management platforms or systems supporting teamwork, is perceived as an expression of the organization's innovative approach and its readiness to adapt to the changing work environment. This, in turn, builds the image of the organization as a modern and future-oriented employer.

The culture of openness and harmony in the organization was also highly rated. Respondents appreciated values such as transparency in communication, mutual respect and supporting teamwork. The culture of openness helps build trust, increases the sense of belonging to the organization and affects employee loyalty. In the environment of an agile organization, where teamwork and quick decision-making are key, this culture turns out to be an indispensable element supporting operational efficiency.

A quick and flexible response to employee needs was indicated as another important factor in building a positive employer image. Organizations that are able to dynamically adapt to employee expectations are perceived as more caring and responsible. Such activities strengthen team engagement and influence the positive perception of the organization by both current and potential employees. The ability to quickly solve problems and the flexibility to adapt to changing staff needs are key aspects of building positive employee experiences.

Multivariate correspondence analysis (MCA) allowed for a deeper understanding of the respondents' response patterns. It was identified that some variables, such as flexibility of work forms and open culture, are closely related, which may indicate their complementarity in the respondents' perception. In turn, other variables, such as the use of modern technologies or quick response to employee needs, are perceived as more independent, which emphasizes their unique nature in the employer branding strategy.

In summary, the research results confirm the importance of a comprehensive approach to building an employer image in agile organizations. Key determinants such as flexibility, innovation, openness and responsiveness must be included in employer branding strategies to

meet the expectations of today's employees. Organizations that effectively integrate these elements have a better chance of attracting and retaining talented employees, which in the long term affects their competitiveness and ability to adapt to the changing work environment. The research conclusions provide valuable advice for organizations that want to effectively build their image as an attractive employer in a dynamic and demanding business environment.

Based on the conclusions obtained, recommendations can be formulated that will help companies effectively build an attractive employer image in agile organizations. It is recommended to introduce flexible forms of work as the foundation of the employer branding strategy. Companies should enable employees to adjust their working hours, introduce remote work options and flexible cooperation models that take into account the individual needs of employees. Flexibility in work organization allows not only to increase employee satisfaction, but also improve their commitment and efficiency.

At the same time, it is recommended to invest in modern technologies supporting work organization and communication in teams. Tools such as project management platforms, applications enabling online collaboration or systems automating everyday processes should be an integral part of the company's operations. The introduction of innovative technological solutions will contribute to improving the efficiency of the organization and will positively affect its perception as a modern employer.

The next step should be to build a culture of openness and harmony in the organization. Promoting values such as transparency, mutual respect and teamwork creates an environment in which employees feel appreciated and engaged. It is worth implementing regular team meetings, soft skills development programs and activities that support integration and communication in the company. Such initiatives strengthen employees' trust in the organization and their sense of belonging.

Companies should also develop systems that allow for a quick response to employee needs. Mechanisms such as platforms for reporting problems, dedicated people responsible for employee support, and a flexible approach to solving emerging challenges can significantly improve relations in the company and increase its attractiveness in the eyes of the team. Organizations that actively respond to employee needs are perceived as more caring and responsible, which has a positive impact on their image.

A holistic approach to employer branding strategy is also recommended, which takes into account the integration of all key elements – flexibility, modernity, openness and responsiveness. These activities should be systematically monitored, and strategies should be regularly updated to keep up with changing employee expectations and dynamic labor market conditions. Effectively combining these elements will allow organizations to attract and retain talented employees, increase their satisfaction and build a lasting competitive advantage in a dynamic business environment.

3. Conclusions

Comparing the results of research on building the employer image in agile organizations with the findings of other researchers, one can notice both similarities and differences in the perception of the key determinants of this process. Research conducted by Gadomska-Lila (2013) indicated that building the image of a good employer is not a common activity, and in many companies the area of human resources management contains significant potential for development in the process of building the image. In turn, Kusibab (2013) emphasizes that activities in the field of building the image of an attractive employer have become increasingly used by managers of various organizations in recent years. The author draws attention to the importance of skillful shaping of the image in a way that attracts the best candidates to the company.

Oczkowska (2015) notes that the process of building an organization's image as an employer consists of several stages, including shaping and consolidating the image. The author emphasizes that the organization's image can be built in several ways, depending on previously conducted activities. In the context of flexible forms of employment, research conducted by Kulp-Puczyńska (2011) indicates the growing importance of flexibility in the labor market. The author analyzes the preparation of vocational school students for flexible forms of employment and work organization, emphasizing the importance of this preparation from the point of view of employment opportunities in the contemporary labor market.

Similarly, the research presented by Oczkowska (2015) indicates different types of the image of an organization as an employer, depending on the criteria taken into account. The author emphasizes that the process of building the image of an organization as an employer consists of several stages, including shaping and consolidating the created image. Analyzing this research in the context of the results presented in the article, it can be seen that flexible forms of work, the use of modern technologies and promoting a culture of openness and harmony in the organization are commonly considered to be key elements of building an attractive employer image. At the same time, the research indicates the need for a more systematic and conscious approach to the employer branding process, taking into account the specificity of the organization and the expectations of potential and current employees.

Future research directions on employer branding in agile organizations may focus on several areas that will allow for a deeper understanding of the mechanisms of this process and its long-term effects. An important direction of research is to extend the analyses to various sectors of the economy, both those with traditional management models and those that combine elements of agility with other approaches. This will allow for the identification of specific challenges and opportunities related to employer branding in various organizational contexts.

Another important area is the analysis of the impact of employer image building determinants on various demographic groups of employees, such as younger generations, experienced employees or people working in various employment models. This type of research will allow for the adjustment of the employer branding strategy to the diverse needs and expectations of employees, which is crucial in a dynamically changing work environment.

Future research may also focus on the long-term effects of employer branding activities. Including a time perspective will allow for the assessment of the effectiveness of selected strategies and their impact on indicators such as employee engagement, retention levels, and job satisfaction. Understanding these long-term relationships will provide valuable guidance for organizations striving to maintain high competitiveness in the labor market.

Another interesting research direction is the analysis of synergies between employer branding elements and other areas of management, such as employee competence development or implementing organizational innovations. This research can show how a comprehensive approach to human resources management supports building the employer's image and what benefits come from integrating various initiatives into a coherent strategy.

It is also worth considering research on the use of advanced analytical tools, such as predictive models or machine learning, in the analysis of employer branding data. Such methods can reveal hidden patterns and relationships that are difficult to detect using traditional research methods. Incorporating qualitative methods, such as in-depth interviews or observations, into research could enrich the understanding of employee motivations and expectations regarding employer branding activities.

Future research may also address global and cross-cultural perspectives on employer branding, which would allow for identifying differences in employer branding strategies between organizations operating in different countries and cultures. Considering this context will provide new, universal and region-specific conclusions that may influence the design of more effective employer branding activities.

The limitations of the research presented in the article concern several important aspects that may affect the interpretation and generalization of the obtained results. First of all, the research was based on a single method, which was a survey, which, despite its effectiveness in collecting respondents' opinions, carries the risk of obtaining subjective answers that do not always fully reflect the actual experiences and attitudes of the respondents. This limitation may result from the tendency of respondents to provide answers that are consistent with social expectations.

Another limitation was the scope of the research sample, which included 303 respondents. Although the sample size is sufficient for statistical analysis, the results may not be fully representative of the general population or other organizations, especially those operating in different industry or cultural contexts. The research was conducted at a specific time, i.e. in April-May 2023, which may mean that the results reflect specific market and social

conditions of that period. In a dynamically changing work environment, the conclusions obtained may change in the long term.

Another aspect is the limitation of the research scope to agile organizations, which means that the obtained results may not be fully adequate for companies with more traditional management structures. The specificity of agile organizations, such as the emphasis on flexibility and innovation, may cause some determinants of employer branding to gain importance, while in other organizational models they may be perceived differently.

In addition, multivariate correspondence analysis (MCA) is an exploratory method, the results of which require interpretation in the context of the phenomenon being studied. There is a risk of simplifying or omitting some relationships in the case of a complex data structure. The results of the analysis should therefore be treated as an introduction to further, more detailed research using various methods, such as in-depth interviews or case studies, which can provide additional context for the obtained results.

Taking into account the indicated limitations, it is worth emphasizing that the research provided valuable information on building the employer image in agile organizations, but their results require further verification in more diverse conditions and using complementary research methods.

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EMPLOYER BRANDING DETERMINANTS IN AN AGILE ORGANIZATION – ANALYSIS OF OWN RESEARCH

Maria KOCOT[1*], Agnieszka WALA[2]

[1] University of Economics in Katowice; maria.kocot@ue.katowice.pl, ORCID: 0000-0001-5150-3765
[2] Jacob of Paradyż Academy in Gorzów Wielkopolski; mbednarczyl@ajp.edu.pl, ORCID: 0000-0002-0257-6279
* Correspondence author

Purpose: The aim of the article is to analyze the determinants of employer branding in agile organizations and to understand their impact on building the image of an attractive employer. The study focuses on identifying key elements, such as flexible forms of work, the use of modern technologies, a culture of openness and quick response to employee needs.
Design/methodology/approach: The research was based on a survey conducted in April-May 2023 among 303 respondents. The collected data was analyzed using multivariate correspondence analysis (MCA), which enabled the identification of relationships between individual employer branding determinants and their perception by respondents.
Findings: The results of the study indicate that the flexibility of the organization, the use of modern technologies and the culture of openness are key factors influencing the attractiveness of the employer. Employees particularly value flexible forms of work and an innovative approach to management, which has a significant impact on their commitment and satisfaction.
Research limitations/implications: The study is limited by the use of only one research tool, which was a survey, and the focus on a sample limited to 303 respondents. Further research could take into account a broader international context and more diverse research methods, such as in-depth interviews or qualitative analysis.
Practical implications: The study results provide practical advice for organizations that want to increase their attractiveness as employers. It is recommended to implement flexible solutions, support a culture of openness and use modern technologies in team management.
Social implications: Building strong employer branding in agile organizations contributes to improving the quality of the work environment, supports employee development and increases their integration with the values of the organization. Activities in this area can also positively influence sustainable social development by creating more responsible and inclusive workplaces.
Originality/value: The article provides an original perspective on employer branding in the context of agile organizations, integrating theoretical perspectives with empirical research results. It is a significant contribution to the development of knowledge on building employer branding in a dynamic business environment.
Keywords: agile organization, Employer Branding, multidimensional correspondence analysis (MCA), organization, employees.
Category of the paper: research paper.

1. Introduction

Modern organizations operate in a dynamically changing environment that requires flexibility, innovation, and the ability to respond quickly to changing conditions. In this context, agile organizations are becoming one of the key management models that allow for effective functioning in a demanding market environment (Routledge, 2020; Sajdak, 2021). At the same time, the importance of employer branding as a tool for attracting and retaining talents, which are a strategic resource of every organization, is growing. When these two perspectives are combined, there is a need for a thorough understanding of how an agile approach affects the building of the employer's image and what determinants of employer branding are key in this organizational model (Akkaya, 2021).

The topic is particularly important in the face of changing employee expectations, for whom the traditional approach to work and management is no longer sufficient. Employees are increasingly looking for flexible forms of work, technological support, a culture of openness and a quick response to their needs. Understanding these expectations and the ability to respond appropriately to them are becoming key determinants of success in building the image of an attractive employer. This topic is also gaining importance in the context of global trends such as digitization, remote work and the growing role of diversity and inclusiveness in organizations (Mrugalska, Ahmed, 2021).

The article consists of several related parts, which together create a coherent analysis of the issue of employer branding in agile organizations. The first part discusses the theoretical foundations of an agile organization and its key determinants, such as structure, organizational culture and technology. Then, the concept of employer branding is presented in the context of contemporary market challenges, emphasizing the importance of flexibility, innovation and social responsibility in building an employer brand. The next part contains the results of empirical research that analyzes the perception of key determinants of employer branding in agile organizations, as well as their impact on the perception of employer attractiveness. Finally, conclusions and practical recommendations for organizations that want to effectively build their image on the labor market are presented.

The aim of the article is to examine and describe the key determinants of employer branding in agile organizations and to understand their importance in building the image of an attractive employer. The article provides both a theoretical and empirical analysis of the topic, which allows for a better understanding of the issues studied. The added value is the use of a holistic approach that combines different perspectives - from management theory to empirical research - to present a comprehensive view of employer branding in the context of organizational agility. The research results and recommendations included in the article can provide valuable guidance for both management practitioners and researchers dealing with this topic.

2. Literature review

2.1. Agile organization in theoretical approach – essence and determinants

Agile organization in theoretical terms is a management concept that focuses on the ability of an organization to quickly and effectively adapt to changing market, technological and social conditions (Chen, Li, 2021; Fiddler, 2017; Nath, Agrawal, 2020). It is an approach that emphasizes flexibility, innovation and the ability to quickly respond to challenges and needs of the environment (Alshehhi, Nobanee, Khare, 2018). In the literature, organizational agility is sometimes defined as the ability to dynamically adjust processes, structures and strategies in order to achieve competitiveness and sustainable development. The essence of an agile organization is its ability to anticipate and use changes as an opportunity for development, not a threat (Luo, Ren, Cao, Hong, 2020). Such an organization is characterized by flat management structures that enable rapid information flow and decision-making. Employee engagement at all levels is also crucial, supporting a culture of openness, collaboration, and continuous improvement (Doz, Kosonen, 2008). Organizational agility assumes that a key factor for success is the ability to learn and adapt in the face of uncertainty and risk (García-Granero, Piedra-Muñoz, Galdeano-Gómez, 2020).

The determinants of an agile organization can be divided into several main areas. The first of them are structural factors, which include the flexibility of the organizational structure, simplified procedures, and decentralization of the decision-making process. Agile organizations abandon excessively complex hierarchies in favor of management models based on cooperation between teams and individuals (Jones, Adam, 2023). Another important determinant is the organizational culture, which promotes innovation, trust, and openness to change. Values such as responsibility, transparency, and willingness to take risks play a key role in creating an environment conducive to agility (Gao, Zhang, Gong, Li, 2020).

Technology and digitalization are other key determinants of an agile organization. Agility requires the skillful use of modern technologies to optimize processes, improve communication, and quickly respond to changing customer needs. Organizations that effectively integrate digital tools into their operations gain an advantage in a dynamic business environment. In the context of technology, tools supporting team collaboration, knowledge management, and process automation are also important. An important aspect of organizational agility is also human factors, which include employee competencies and attitudes (Sedej, Justinek, 2021). In agile organizations, skills such as creativity, the ability to work in teams, quick learning, and openness to change are particularly valued. Leaders in agile organizations act as mentors and catalysts for change, inspiring employees to take the initiative and engage in innovation processes (Rosário, Raimundo, 2021).

Theoretically, an agile organization is also strongly linked to the idea of sustainable development. Agility does not only mean short-term adaptation to changes, but also building a long-term ability to respond to challenges related to globalization, climate change or social pressure. Agile organizations are perceived as more resilient to crises and able to create value for their stakeholders in a responsible and sustainable way (Seifollahi, Shirazian, 2021).

In summary, an agile organization in theoretical terms is a model based on flexibility, innovation and adaptability. Determinants of agility include organizational structures, culture, technology and human factors, which together create the basis for effective functioning in a dynamically changing business environment. Developing an agile organization requires both a change in thinking and the adaptation of processes, structures and strategies in order to achieve long-term success.

2.2. Employer Branding Concept

The concept of employer branding refers to building and managing the employer's image, which is perceived by both current and potential employees. It is a strategic approach that aims to create an organization as an attractive place of work, where employees can fulfill their professional ambitions, develop skills and achieve professional satisfaction (Martin, 2008). The contemporary approach to employer branding assumes that it is a multidimensional process, combining marketing, management and social aspects, which together create a coherent image of the employer on the market (Szkudlarek, 2022).

One of the key assumptions of employer branding is to adapt the organization's strategy to the expectations of employees and market trends. The employer's image is not based solely on promotional activities, but on the actual value offered to employees, called Employee Value Proposition (EVP) (Rzewuska, Majewska, Berłowski, Woźniak, Marciniak, 2013). EVP includes financial benefits, professional development, organizational culture, and the possibility of balancing professional and private life. A properly defined EVP allows the organization to attract talents that are consistent with its mission and values, which affects the quality of recruitment and the level of employee engagement (Zając-Pałdyna, 2020).

The concept of employer branding includes two main dimensions: external and internal. In the external dimension, activities focus on building a positive image of the organization on the labor market through recruitment campaigns, presence in social media and participation in industry events. External employer branding focuses on attracting new talents and building awareness of the employer's brand among potential candidates (Lane, 2016). In the internal dimension, this concept refers to creating a work environment that supports employee development, builds their commitment and loyalty to the organization. Internal activities include development programs, motivational systems, integration initiatives and transparent communication (Matuszewska-Kubicz, 2020).

The literature emphasizes the growing importance of employer branding in the context of changing employee expectations and the labor market (Gillis, 2006). Employees increasingly expect not only employment stability, but also development opportunities, work flexibility, and alignment of the organization's values with their own beliefs (Mayo, 2001; Burke, 2007). This phenomenon leads to a change in the approach of employers, who must constantly adapt their strategies to these expectations in order to attract and retain the most talented employees (Jenner, Taylor, 2008).

Employer branding is also important in building an organization's competitive advantage. Companies perceived as attractive employers are more likely to attract the best candidates and retain key employees, which affects their efficiency and innovation (Kozłowski, 2016). Research shows that a strong employer brand reduces recruitment costs, increases retention and improves the organization's financial results. In this context, employer branding is not only an element of HR strategy, but also an important component of business strategy (Żółkiewicz, Olszewski, Czarnecki, 2021).

The importance of technology in employer branding is constantly growing, especially in the digital era. Tools such as social media, recruitment platforms and talent management systems allow organizations to reach a wide audience and personalize communication (Dąbrowska, 2014). Data analysis allows companies to better understand the expectations of potential candidates and adapt their activities to their needs. The modern approach to employer branding also includes the aspect of social responsibility and sustainable development. Employers who actively engage in pro-social and ecological activities are perceived as more attractive by younger generations of employees (Grzybowska, 2022). Transparency and authenticity in employer branding activities are becoming key in building trust among both current and future employees (Rosethorn, Mensink, 2008).

In summary, the employer branding concept is a multidimensional approach that combines management, marketing and communication activities to build a strong and attractive employer brand. It is a dynamic process that requires continuous monitoring of the labor market, analysis of employee needs and adjustment of strategies to changing conditions. Thanks to properly planned and implemented employer branding activities, organizations can not only attract and retain talent, but also build their competitive position on the market.

2.3. Employer Branding in an Agile Organization

Employer branding in an agile organization is a key element in building its image as an attractive employer, especially in a dynamically changing market environment. In agile organizations, which are characterized by flexibility, speed of action and the ability to adapt, employer branding must take into account the specificity of this type of work environment. The essence of activities in this area is to create a unique value proposition that combines the needs of the organization with the expectations of current and potential employees (Lendzion, 2023).

One of the foundations of employer branding in an agile organization is providing flexible forms of work, which play an important role in attracting talent. This flexibility is manifested in various aspects, such as the possibility of remote work, flexible working hours or the choice of a cooperation model adapted to the individual preferences of employees (Rahimi, Mansouri, 2019). In the environment of agile organizations, where the priority is to quickly adapt to changing conditions, this flexibility becomes one of the key determinants of employer attractiveness. Employees looking for a balance between work and private life increasingly pay attention to the possibility of adapting work to their needs, which makes flexibility an important aspect of the employer branding strategy (Wojtaszczyk, 2012).

The use of modern technologies is another important element supporting employer branding in agile organizations. Innovative tools and systems not only support operational efficiency, but also improve employee experience (Miś, 2020). Technology enables smoother communication, faster access to resources and facilitates teamwork, which is especially important in dynamic work environments (Kurnia, Chien, 2020). The use of modern solutions, such as project management tools or platforms supporting collaboration, not only improves the quality of work, but also increases the attractiveness of the organization in the eyes of potential candidates. Employers who effectively integrate technologies with everyday processes are perceived as modern and innovative, which strengthens their image on the labor market (Stuss, 2021).

Creating a culture of openness and harmony in the organization plays a key role in building the employer image in agile organizations. Such a culture promotes trust, strengthens the sense of belonging and supports cooperation between teams. Agile organizations that promote openness in communication and transparency in decision-making are more attractive to employees who value the opportunity to express their opinions and influence the functioning of the organization (Prieto, Talukder, 2023). Additionally, harmony in the workplace, achieved by supporting work-life balance and respect for diversity, is an important element of the employer branding strategy, influencing positive employee experiences (Zak, 2022).

Quick and flexible response to employee needs is another aspect that distinguishes employer branding in agile organizations. Organizations that can quickly identify and respond to the changing expectations of their employees build the image of a caring and responsive employer. This approach requires advanced mechanisms for monitoring employee needs and effective processes for managing their expectations. In agile organizations, where change is a constant element, the ability to respond quickly becomes an indispensable component of building a positive image (Machnicka, 2020).

In summary, employer branding in an agile organization focuses on elements that reflect its flexibility, innovation and ability to respond to employee needs. It includes not only activities aimed at attracting new talent, but also retaining and developing current employees, which is particularly important in the dynamic environment of agile organizations. An effective employer branding strategy supports building competitiveness on the labor market,

while strengthening the commitment and satisfaction of teams, which are key to the success of the organization.

3. Methods

The aim of the research was to identify the key determinants of employer branding in an agile organization and to determine how individual elements affect the perception of the organization as an attractive employer. The research also aimed to determine the relationship between selected factors and employee preferences in the context of building the employer's image. A hypothesis was put forward that key elements of employer branding, such as flexible forms of work, the use of modern technologies, promoting a culture of openness and harmony, as well as responding to employee needs, significantly affect the positive perception of the organization by employees.

The research was based on research questions regarding which determinants of employer branding are most important from the respondents' perspective, what relationships exist between the individual elements of building the employer image, and how these relationships influence the perception of the organisation as agile and attractive.

The research method was a survey conducted in April-May 2023 on a sample of 303 respondents. The research tool allowed for collecting data on respondents' assessments of various aspects of employer branding. After collecting the data, multivariate correspondence analysis (MCA) was conducted to identify hidden patterns in the responses and determine the relationships between the analyzed variables. This analysis allowed for the visualization of data in a multidimensional space, which facilitated the interpretation of the results, especially in the context of dependencies and similarities between categories.

The MCA was conducted to show which employer branding determinants are closely related and which of them have the greatest impact on the perception of the organization. The analysis also provided guidance on the priorities of employees in the area of employer branding, enabling better adjustment of the organization's strategy to their needs and expectations.

4. Results

The study attempted to identify the determinants of employer branding in an agile organization by analyzing the respondents' answers to questions about various aspects of building the employer's image (see Table 1). In the case of the variable concerning the provision

of flexible forms of work as an element of attracting talent, 10 people definitely did not answer, 20 respondents rather did not choose, 30 people indicated no opinion, while 110 participants of the study answered rather yes, and 133 definitely yes.

Table 1.
Determinants of Employer Branding in an Agile Organization

Variable	Definitely NOT	I don't think so	I have no opinion	Probably YES	Definitely YES
Providing flexible work arrangements as an element of attracting talent (1)	10	20	30	110	133
Using modern technologies to support building the employer image (2)	12	18	45	100	128
Creating a culture of openness and harmony in the organization (3)	8	15	40	105	135
Quick and flexible response to employee needs (4)	11	17	35	95	145

Source: Own study based on research.

For the variable related to the use of modern technologies as support in building the employer's image, 12 respondents gave a definite no answer, 18 respondents rather didn't, 45 respondents indicated no opinion, 100 respondents rather yes, and 128 participants answered definitely yes. Another variable, concerning the creation of a culture of openness and harmony in the organization, received answers of definitely no from 8 respondents, rather no from 15 respondents, 40 respondents indicated no opinion, 105 participants rather yes, and 135 respondents answered definitely yes. In relation to the variable related to quick and flexible response to employee needs, 11 respondents chose the answer definitely no, 17 indicated rather no, 35 people declared no opinion, 95 participants rather yes, while 145 people expressed a definitely positive position on this issue.

The results indicate a diversity of opinions with respect to each of the analyzed variables, which allows for further consideration of their significance in the context of building the employer image in an agile organization.

In order to better understand the relationship between the determinants of employer branding in an agile organization and the way they are perceived by respondents, a multidimensional correspondence analysis (MCA) was conducted (see Figure 1). Its main goal was to examine how individual aspects of building the employer image, such as offering flexible forms of work, using modern technologies, promoting a culture of openness and harmony, or quickly responding to employee needs, are assessed by the study participants. The analysis allows for the identification of response patterns and relationships between categories that could be difficult to notice in traditional data analysis methods.

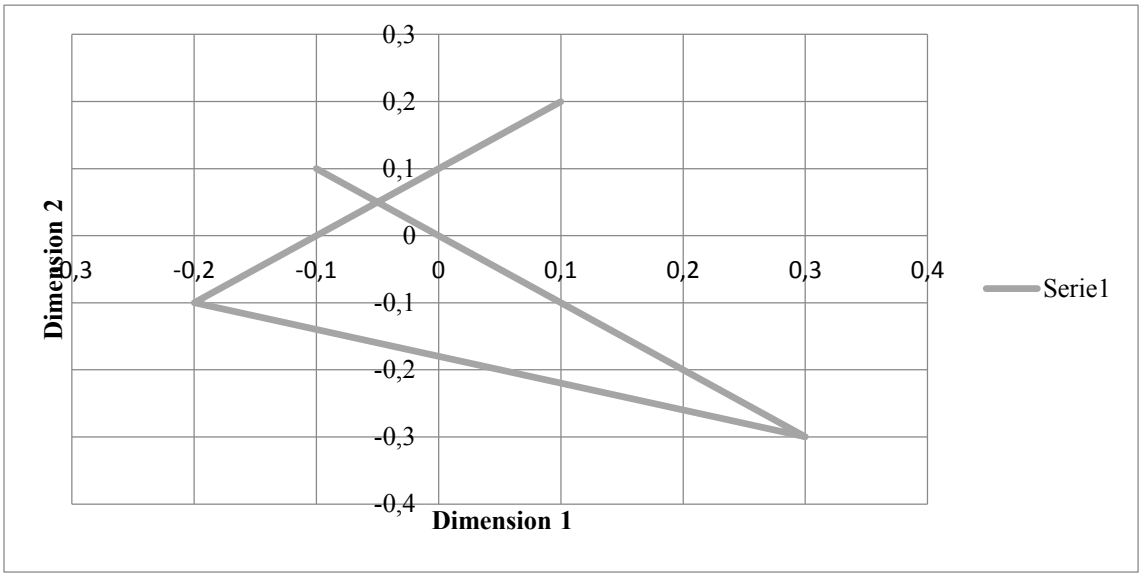

Figure 1. MCA Plot: Employer Branding Indicators.

Source: Own study.

By conducting MCA, the data was transformed into a multidimensional space, allowing its structure to be visualized in the form of a graph. This made it possible to illustrate similarities and differences between variables and assess their mutual relationships. For example, the proximity of certain response categories may suggest that they are perceived by respondents in a similar way, which allows conclusions to be drawn about employees' preferences and priorities. On the other hand, variables that are distant from each other may indicate differences in the perception of these aspects.

The results of the analysis indicate which elements of employer branding are most important from the perspective of respondents and how individual groups of answers, such as "Definitely YES" or "Rather YES", are distributed in relation to the analyzed variables. This analysis allows for a better understanding of the key aspects that affect the perception of the organization as an attractive employer, and the identification of areas requiring special attention. It is also a starting point for developing a strategy for building the employer's image in an agile organization, which will be more adapted to the needs and expectations of employees. Thanks to the use of MCA, it is also possible to precisely determine which actions can bring the greatest benefits in the context of increasing employee engagement and satisfaction.

5. Discussion

The conducted research indicates that the determinants of employer branding in an agile organization are perceived by respondents as important elements of building the employer's image, with their importance varying depending on the aspect analyzed. The key factor that gained the greatest recognition among the respondents turned out to be providing flexible forms

of work, which indicates growing expectations towards employers in terms of adapting working conditions to the individual needs of employees. Respondents particularly appreciate the possibility of adjusting working hours, work mode and other flexible solutions that allow for balancing professional and private life.

An important aspect of employer branding is also the implementation of modern technologies that support work-life balance. Respondents see the value of technology in facilitating communication, work organization and increasing efficiency, which emphasizes their importance in building a positive image of the employer. The introduction of innovative work tools can be seen as a manifestation of the organization's modern approach, which affects its attractiveness in the eyes of employees.

Promoting a culture of openness and harmony in the organization was also highly rated by respondents. The results indicate that creating an environment conducive to cooperation, mutual respect and transparent communication is seen as one of the pillars of an agile organization. A culture of openness is not only appreciated by employees, but also contributes to increasing commitment and loyalty to the employer.

Quick and flexible response to employee needs is another important determinant of employer branding that gained high recognition in the study. A responsible and quick approach to solving employee problems is perceived as an expression of care and professionalism of the organization, which significantly affects its image. These results confirm that agile organizations that can quickly adapt to changing employee expectations are better perceived by their teams.

It is recommended that companies, especially those operating in dynamic and agile environments, focus their activities on creating comprehensive employer branding strategies that combine various aspects influencing the attractiveness of the employer. A key element of these activities should be the introduction of flexible forms of work that allow employees to adjust their working conditions to their individual needs. Organizations should consider implementing solutions such as flexible working hours, the possibility of remote work and choosing a preferred work model, which will contribute to increased employee satisfaction and engagement. It is also important to invest in modern technologies that support work-life balance and increase work efficiency. These technologies may include tools for remote collaboration, digital communication platforms or applications supporting work organization. An innovative approach in this area not only strengthens the company's image as a modern employer, but also responds to the growing expectations of employees related to the digitization of the work environment.

Companies should place particular emphasis on promoting a culture of openness and harmony that fosters cooperation, mutual respect and transparent communication. Activities in this area may include introducing soft skills development programs, organizing regular team meetings, and building a space where employees feel heard and appreciated. Creating a culture of openness helps strengthen the bond between employees and the organization, which affects

their long-term loyalty. Quick and flexible response to employee needs should become a standard in the functioning of companies. It is recommended to develop systems for reporting and resolving employee problems and create mechanisms that allow the organization to quickly adapt to changing expectations. This approach demonstrates a high level of care for employees and contributes to building a positive image of the company.

The need for coherence and mutual complementation of employer branding activities is emphasized. Companies should integrate various initiatives to create a comprehensive strategy that responds to the key needs and expectations of employees. Implementing flexible solutions combined with modern technologies, building a culture of openness and responsiveness to the needs of the team can together create a strong foundation for building the image of an attractive employer. The long-term goal should be systematic monitoring of employee needs and regular updating of the employer branding strategy in response to changing market and social conditions. This approach will allow companies not only to attract the best talents, but also to increase the level of engagement and retention in the team, which is crucial in the context of organizational agility and efficiency.

6. Conclusions

It is worth comparing the results of the conducted research with the findings of other researchers. This comparison reveals both similarities and differences in the key determinants of employer branding in agile organizations. Näppä's study (2023) emphasizes the importance of co-creating the employer brand through the integration of strategy and organizational identity. These results indicate that organizations encounter difficulties in understanding and comparing employer branding practices, which makes it difficult to assess their own brand. Two main areas of focus were identified: building strategic structures and a collective identity consistent with brand values. Organizations differ in these dimensions, which affects the effectiveness of their employer branding activities.

Koch and Schermuly (2021) examined the impact of agile project management on organizational attractiveness and employee engagement. They found that agile project management indirectly affects organizational attractiveness through psychological empowerment of employees. People with high levels of sensation seeking are more attracted to organizations using agile methodologies. This suggests that agile practices can be an effective element of employer branding strategies, attracting professionals looking for modern and dynamic work environments.

Easa and Bazzi (2020) reviewed the literature on employer branding, emphasizing its role in increasing employer attractiveness, employee engagement, and retention. Employer branding was shown to be a key tool in attracting and retaining talent, as well as in building competitive

advantage. It is recommended that organizations develop unique value propositions for employees that meet their expectations and needs.

In summary, the results of the conducted research are consistent with the findings of other researchers, emphasizing the importance of flexible forms of work, modern technologies, a culture of openness and quick response to employee needs as key elements of an effective employer branding strategy in agile organizations. Integration of these elements can contribute to increasing the attractiveness of the employer and employee engagement and retention.

When analyzing the limitations of the research, it is possible to point out several key areas that may affect the interpretation and generalization of the results. First, the research was conducted only in the context of agile organizations, which limits the possibility of relating the results to organizations operating in more traditional management structures. The results may not be fully representative of companies that do not use agile methodology, and their approach to employer branding may differ significantly from the analyzed case.

Another limitation was the data collection method, based on a survey, which, despite its effectiveness in obtaining respondents' opinions, carries the risk of subjective answers. Respondents could provide answers that were consistent with social expectations, which may affect the reliability of the obtained results. In addition, the lack of the possibility of conducting in-depth interviews or other qualitative methods limits the understanding of the motivations behind respondents' answers.

Another limitation is the time and geographical framework of the study, which was conducted in April-May 2023 on a sample of 303 respondents. The results may reflect specific market and cultural conditions that will not necessarily be consistent with the situation in other countries or at a later time. The sample, although sufficient for specific analyses, may be considered relatively small in the context of broader comparative research. Another limitation of the MCA analysis used in the study is that it requires the interpretation of data in the context of their multidimensional relationships, which may lead to simplification or overlooking of certain relationships. The results of this analysis are exploratory in nature and should be treated as a prelude to more detailed research.

The identified limitations may constitute the basis for further research that would take into account a wider scope of organizations, more diverse research methods and a larger sample of respondents, which would allow for a deeper understanding of the issues studied.

Future research directions may focus on broadening the context of employer branding analyses to include various types of organizations, including those operating in traditional management models as well as hybrid organizations. It is worth considering comparative studies that would allow for the identification of differences in the perception of employer branding determinants between organizations from different sectors, organizational cultures and countries. Such studies may provide valuable clues regarding the universality and specificity of selected employer image building strategies.

Another research area could be to deepen the understanding of the impact of individual employer branding elements on different demographic groups of employees, such as younger, more experienced, or those working in different employment models. This research could include an analysis of employee expectations and priorities regarding flexible forms of work, the implementation of modern technologies, or organizational culture. Particular attention should be paid to the specific needs of employees in agile organizations that differ from traditional structures.

An interesting direction of research may also be the analysis of the long-term impact of employer branding activities on employee engagement, retention and satisfaction indicators. Including a time perspective would allow for the assessment of the effectiveness of selected strategies and their adaptation in a dynamically changing work environment. It may also be important to examine the synergy between employer branding determinants and other areas of management, such as competence development or organizational innovations.

Further research may also include the use of advanced analytical tools, such as predictive models or machine learning, which will allow for the identification of hidden patterns and relationships in the data. The inclusion of qualitative methods, such as in-depth interviews or observations, could also enrich the understanding of employee motivations and expectations towards employer branding activities. Extending research in this direction would provide valuable practical advice for organizations striving to build a strong image of an attractive employer.

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INFORMATION MANAGEMENT THROUGH SOCIAL NETWORKS IN SELECTED SPORTS CLUBS

Sławomir KOWALSKI

Faculty of Management, Częstochowa University of Technology; slawomir.kowalski@pcz.pl,
ORCID: 0000-0002-5421-5053

Purpose: The main purpose of the article is to verify the similarity of ratings of groups of social media types. The study was conducted on speedway sport fans in Poland. An additional aim is to find differences in the perception of the variety of factors influencing the attractiveness and quality of social media pages. The reason for the article was also the need to find a relatively new and easy method to study media diversity in order to make decisions about managing communication with content audiences.
Design/methodology/approach: The main interview method was used to achieve the intended purpose, based on a survey questionnaire targeted at active social media users of speedway clubs. Based on numerical data collected between 21 and 31 October 2024, a hypothesis was made about the homogeneity of social media use and the factors influencing the quality of communication. The data were statistically analysed using the Kruskal-Wallis ANOVA test. The subject of the study was respondents' assessments of the degree of comparability of fads and the factors characterising them. Only the evaluations of respondents who were active on social media were included in the study.
Results: The results of the study provided statistical characteristics to verify the hypothesis of similarity of social media-related characteristics according to the procedure presented.
Limitations/conclusions of the study: The main limitations of the study are the variety of factors that can influence communication management in sports organisations, as well as the multi-channel nature of the methods of reaching stakeholders. The paper focuses mainly on social media differences without identifying the strength of these differences. In the future, this approach can be adapted to address communication management issues, but requires more explicit results.
Practical implications: the Kruskal-Wallis ANOVA method is a modification of the existing ANOVA/MANOVA method. The in-depth method used in this paper was chosen because in comparative tests the basic condition is a normal distribution for the individual series. The method used allows this condition to be bypassed, and this allows it to be used freely to learn about the assessment of social media homogeneity. It provides sports companies with a tool to recognise their competitive position in terms of marketing communication and the effectiveness of its online tools.
Social implications: It is assumed that with the optimal application of the proposed research method, a tool is gained to objectively assess the homogeneity of the media and the factors that characterise it. This allows for a more effective management of communication outside the

sports organisation. The method replaces the qualitative assessment of this management by showing the position among different types of media or factors.
Originality/value: The article targets different companies active in the online space in multiple social media. The novelty is that the data obtained in the face-to-face survey provides a basis for analysis and answers the question of diversity and quality. The method used for social media is included for the first time. Knowledge of the diversity of groups influences communication management.
Keywords: social media, management, communication.
Category of the paper: Research paper.

1. Introduction

Social media are among those means of communication with the corporate environment that still require a great deal of research. The need for research stems from the constant dynamism and flexibility of these media and the variety of issues that have not yet been discovered or are too vast to be studied. There is also still a lack of sufficient scientific tools to enable the efficient management of communication, promotion, pricing policy, etc. Because of this scientific gap, it is necessary to try to understand the power of messages, the behaviour of their recipients, the factors influencing the perceived attractiveness of social profiles or verifying knowledge about the diversity of the types of these profiles.

In the world, social media has been around for a long time. The first definitions of the term emphasise the close relationship of these media with communities, technology and content. C. Treadaway and M. Smith defined social media as a set of technologies for initiating communication and sending content between people, their friends and social networks, which include. A.M. Kaplan and Haenlein as a group of applications based technologically and ideologically on Web 2.0 and allowing the creation and exchange of user-generated content.

Other researchers developed the term and related elements (Larimo et al., 2021; Oprea, 2023; Rhee et al., 2021), and a summary of the definition was provided by T. Aichner et al. including technological solutions as early as 1994 in social media (Aichner et al., 2021).

In Poland, social media have also been dealt with. Even today, due to the multitude of scientific possibilities, it is still a topic that is being addressed, mainly in connection with specific entities such as cultural institutions, museums, local government units and many other forms of activities (Nawrocka, Zaprucka, 2022; Jeż, 2020; Jankowska, 2024).

People around the world are largely engaged and attached to web 2.0 technologies and social media platforms. For the same reason, companies are beginning to see such technologies as effective mechanisms to interact more with their customers. Similarly, related issues of social media marketing have also become the focus of scholars and researchers to expand the current knowledge of such phenomena in the field of marketing (Alalwan et al., 2017).

Social media such as blog, Facebook, Twitter, Instagram, WhatsApp, etc., have gained popularity worldwide (Razak, Latip, 2016; Vinerean et al., 2013; Maryam 2015).

There is a very high correlation between social media and marketing. The specific features of social media and its widespread use have primarily transformed marketing methods from traditional to online, especially in communication (Dahnil, 2014). Social media also enables communication between companies and customers around the world, at any time (Rapp, 2013; Brogi, 2013; Sarangan, Ragel 2014).

Social media marketing can be seen as the business practice of marketing brands, goods, services, information and opinions through a social media platform. In today's business world, marketing activities through social media applications enable companies and customers to discuss and share information with each other. As an interactive platform, social media enables companies to engage existing customers and attract new ones, generate more sales, build brand awareness and brand image (Kietzmann et al., 2011; Chanthinok, 2015; Karimi, Naghibi, 2015).

2. Social media in marketing od sport

As already mentioned, social media marketing has been defined as ‘the use of social media technologies, channels and software to create, communicate, deliver and exchange offers that have value to an organisation's stakeholders’ (Cartwright, 2021; Tuten, Solomon, 2014).

The proliferation of social networks means that their functionality is expanding all the time. Social media allows you to showcase yourself, your company or the products you offer. Profiles can contain all sorts of information on the subject, as well as enabling people to network, exchange information and maintain relationships with site members. In this way, companies can maintain relationships with their customers and receive feedback from them containing opinions on products or services. Social media also allows users' activities to be observed and thus provides an opportunity for companies to showcase their activities, investments or volunteering. In this way, they become a tool for creating a company's image. Each service, although providing similar functions, is based on the different nature of the links and contacts that exist between its users.

The use of social media and its use in business management also depends on generational differences (Karasek, Hysa, 2020). Social media engagement can be understood in many ways. Each social media can also be assessed separately. Engagement is then examined as the intensity of interactions and their implications, vis-à-vis the offers and activities of a brand, product or company, regardless of whether the initiator is an individual or a company. Alongside traditional marketing channels, social networks are being integrated into the

marketing mix. Social media have changed the dynamics of interaction between companies and consumers, who favour this relationship.

In the context of media use, a very important aspect is defining who the audience of media content is (Jacobson et al., 2020). It is the audience that decides what they watch, it is also their judgements that determine the direction in which a medium develops (Jamilat et al., 2022). Audiences through the media also show their power and importance in promoting brands (Susanto et al., 2022). One can venture the view that audiences determine the development of companies.

There are many arenas where social media are present. One of these is sport. Social media has revolutionised the ways in which the world creates, shares and consumes content. The unique characteristics of social media, such as ease of networking, instant global reach, lack of access control and ease of collaboration, have made the various platforms extremely powerful multi-functional tools. At this point, it is important to introduce the definition of social media used in this commentary.

With the rapid expansion of social media, researchers using different methods and perspectives have developed an interest in studying the role of social media in sport. The field of sport research is relatively broad and encompasses a diverse set of disciplines, such as sport law, sport economics, sport marketing, sport finance, sport sociology, sport management, sport tourism, sport facility and event management, sport communication, sport organisation behaviour and theory, and sport for development (Abeza et al., 2015).

Among foreign researchers, the topic of the use of social media in sport has been most extensively covered by T. Newman, J. Peck and B. Wilhide (Newman et al., 2017) dedicating their book ‘Social media in sport marketing’ to this topic. Other researchers have focused on the multi-faceted importance of the Internet in sport from analysing it as a tool for promoting sporting events to researching current media activity (Miranda et al., 2024; Kennedy et al., 2024; Dunn et al., 2024; Bagic Babac, Podobnik, 2024). Academic studies on the use of social media in the management of a sports institution are dominated by case studies, analyses of media effectiveness or media user behaviour.

There are relatively few Polish-language studies on the use of social media in sport. The field is dominated by master's thesis studies or case studies (Bik, 2024; Jurek, 2024).

This article continues the theme of the use of social media in sports institutions in information management (Kowalski, 2024). This article uses the Kruskal-Wallis ANOVA test, which is a non-parametric alternative to the one-way analysis of variance. Using this test, we compare the distributions of several variables (Cole, 1993; Swallow, 1984; Kruskal, Wish, 1978).

The research subjects in this case are respondents who are social media users of sports clubs, and the article is part of a larger research project. Looking more broadly, sports companies are specific in that they hardly compete with each other. The primary method of communication management here is benchmarking, a method that involves comparing the processes and

practices of one's own entity with those of companies considered to be the best in the field under analysis. Another peculiarity of sports organisations is the high level of social media activity. This is due to the nature of the audience of the content (the fan), for whom sport is associated with personal emotions. Social media satisfies the need to be close to sporting events related to the club and its ongoing activities. In most other businesses, this need is not present.

The result of these conditions is a situation in which, theoretically, marketing communications in sports clubs should be almost identical, undifferentiated, homogeneous. Similarly homogeneous, therefore, should be the assessments of the types of social media or the factors influencing the attractiveness of these media. This article aims to verify this opinion.

3. Research methods

The research is part of a larger research project dedicated to the issues of sports companies' communication on the Internet. The aim of this analysis is to verify the degree of similarity in the use of online communication tools by speedway sports clubs in Poland. The basis for the consideration is the evaluations of social media users regarding both the types of media and the factors influencing the attractiveness of individual profiles. The main survey was conducted on 345 people, from which only those with accounts on individual social media sites were selected. The survey ran from 21 to 31 October 2024, until a number of more than 300 respondents was obtained to ensure the desired representativeness of the study. Based on these figures, it was hypothesised that the different types and factors influencing the perception of their attractiveness are homogeneous.

To verify this hypothesis, the numerical data were statistically analysed using the Kruskal-Wallis ANOVA test. Initially, the use of a one-way analysis of variance ANOVA test was considered to determine whether there were statistically significant differences between the predictor groups being compared and the dependent variable. After a preliminary analysis, it was found that the factors did not have a normal distribution. A Kruskal-Wallis ANOVA test, based on ranks, was therefore applied in this case. This test is a non-parametric alternative to the one-way analysis of variance. With this test, we compare the distributions of several (k) variables:

The null hypothesis is that all samples come from one population and the alternative hypothesis is that not all samples come from one population, viz:

- in the case of study 1, the null hypothesis assumes that, regardless of the type of media, their ratings are the same in the user group,
- in the case of study 2, the hypothesis assumes that, irrespective of the factor influencing the attractiveness of a social profile, its ratings are the same in the user group.

The test procedure is based on the calculation of the T-statistic according to the formula 1:

$$T = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3\,(n+1) \tag{1}$$

where:
R*i* - sum of ranks in the i-th group,
n*i* - abundance of the i-th group,
n - total size of all groups.

If there are no grounds to reject the null hypothesis then the statistic has a $\chi 2$ distribution with k-1 degrees of freedom (right-hand critical area).

This procedure is used to determine whether the respondents' ratings expressed on a Likert scale (answers: strongly agree, agree, have no opinion, disagree, strongly disagree) are homogeneous within the group of social media types and within the group of factors influencing the perception of their attractiveness.

The data were also corrected for according to Dunn's test, introducing a correction for tied ranks according to the formula.

$$C = 1 - \frac{\sum(t^3 - t)}{n^3 - n} \tag{2}$$

where t - the number of cases included in the tied rank.

Once the tied rank has been taken into account, information is obtained on whether the different communities included in the study differ significantly from each other, i.e. in this case, whether the evaluators of the types of social media and the factors influencing their attractiveness are independent of each other or homogeneous in these evaluations. Verification of this opinion is intended to allow a decision to adjust the management of media and information to the degree of diversity shown.

4. The study results

Both the types of social media and the evaluation of their attractiveness were subjected to the same procedure. The study was therefore divided into two parts, and in order to compare the variables in question, the same procedure was used according to the qualitative Kruskal-Wallis ANOVA method, verified by the Dunn post hoc test.

The null hypothesis, stating that regardless of the type of social media, the results are the same (homogeneous), should be rejected when the test statistic is greater than the number defining the critical area with 4 degrees of freedom and an assumed level of significance (0.05).

For the second set of distributions, the null hypothesis that regardless of the factor influencing the attractiveness of the social medium, the results are the same (homogeneous) should be rejected when the test statistic is greater than the number defining the critical area with 6 degrees of freedom and an assumed level of significance (0.05).

The starting point for the calculations was a graph created as a result of a face-to-face survey conducted on a group of active users of individual speedway clubs' social media in Poland. The size of these groups is not constant, as some of the respondents did not answer the question. The study took into account evaluations of the different types of media and evaluations of the factors influencing the perception of the attractiveness of the various profiles of speedway clubs. An additional assumption was made that respondents rated clubs with which they sympathised and whose profiles they were familiar with.

In both parts, the evaluation was based on a Likert scale, and portal users were asked to tick which sentences they agreed with. The first part involved responding to the sentence 'The club runs its Facebook/Instagram/X, Youtube/Tik/Tok profile in an exemplary manner'. The data in graphical form is shown in Figure 1.

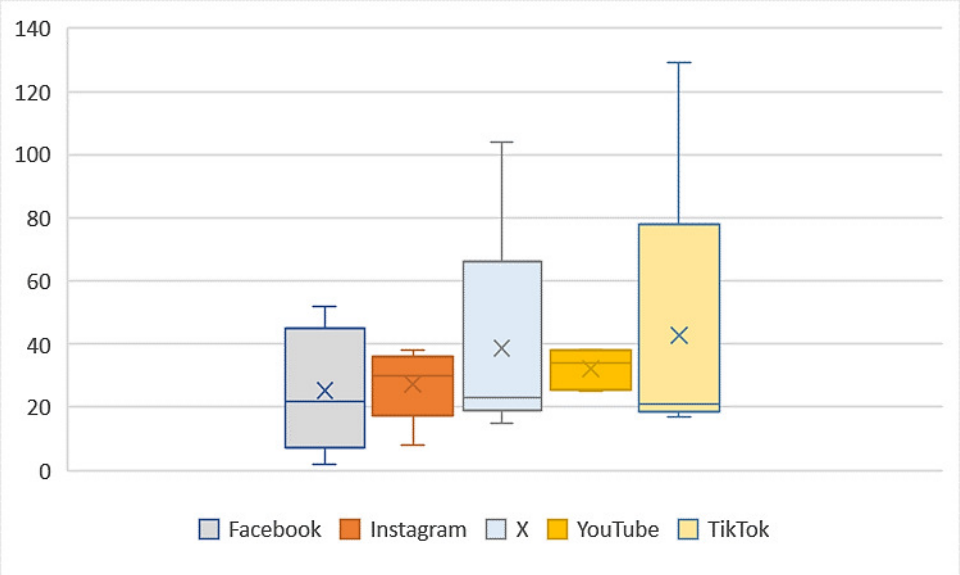

Figure 1. Graphics of social media type ratings.

Source: Own compilation based on data from reaserch.

The graphic presented in Figure 1 gives a cursory idea of how varied the responses are in assessing agreement with the opinion presented. However, this is too little to determine whether the types of social media are statistically evaluated differently by respondents. Therefore, calculations of basic statistical measures have been made and are presented in Table 1.

Table 1.
User ratings of particular types of social media

	Facebook	Rank	Instagram	Rank	X	Rank	YouTube	Rank	TikTok	Rank
I strongly agree	2	1	30	18	104	29	38	22,5	129	30
I tend to agree	12	4	8	2	23	10,5	25	13	21	8
I don't have an opinion	22	9	27	15,5	15	5	26	14	20	7
I don't think I agree	38	22,5	34	19,5	28	17	38	22,5	27	15,5
I strongly disagree	52	26	38	22,5	23	10,5	34	19,5	17	6
Rank summary	**x**	**62,5**	**x**	**77,5**	**x**	**72**	**x**	**91,5**	**x**	**66,5**
Average	126	x	137	x	193	x	161	x	214	x
Standard deviation	25,2	x	27,4	x	38,6	x	32,2	x	42,8	x
Variance	17,92	x	10,38	x	32,96	x	5,67	x	43,22	x
Coefficient of variation	71,1%	x	37,9%	x	85,4%	x	17,6%	x	101%	x

Source: Own compilation based on data from reaserch.

A high degree of homogeneity is apparent in the data in Table 1. The mean of the ratings ranges from 25.2 to 42.8 and the variance from 5.67 to 43.22. The social media that differs most from the others is TikTok. The coefficients of variation expressed by the ratio of the standard deviation to the mean indicate a wide dispersion of individual ratings. The smallest for Yotube, the largest for TikTok.

As the numbers are not clear and sufficient, the procedure presented earlier in this article was used.

This led to the following calculations, from the determination of the empirical statistics to the verification of the null hypothesis that all samples come from one population, and the alternative hypothesis that not all samples come from one population (being homogeneous or heterogeneous). Figures are presented to four decimal places.

$$T = \frac{12}{25(25+1)}\ 5578{,}2 - 3\ (25+1) = \ 0{,}0185 * 5578{,}2 - 78 = 24{,}9822 \qquad (3)$$

Due to the existence of associated ranks in the distribution, post hoc calculations were performed according to the Dunn test, where the coefficient C was 0.9964.

$$C = 1 - \frac{55}{15600} = 0{,}9964 \qquad (4)$$

After adjustment, the final empirical value is the product of the T and C coefficients, i.e. 24.8941 (24.9822*0.9964). The null hypothesis, stating that regardless of the type of social media, the results are the same (homogeneous), should be rejected when the test statistic is greater than the number that defines the critical area with 4 degrees of freedom and an assumed level of significance (0.05). This statistic is 9.9477, so the hypothesis of homogeneity of social media types should be rejected, i.e. the media as perceived by fans/social media users are different from each other and should be managed differently.

As it is too general to verify the hypothesis of homogeneity of social media type, the statistical analysis was deepened by assessing the factors influencing the attractiveness of social media sites. These factors were: curiosities, videos fronting the life of the club, forum (chat), frequency of content updates, games (competitions, fan/user games), site transparency and colour scheme. In this case, as before, the same method of testing homogeneity was used with the Kruskal-Wallis ANOVA test and the Dunn post hoc test. Figure 2 shows the overall magnitudes for these factors in graphical form. In the second part of the survey, respondents responded to the sentence 'I rate curiosities, videos etc.) as exemplary'. The data is shown in Figure 2.

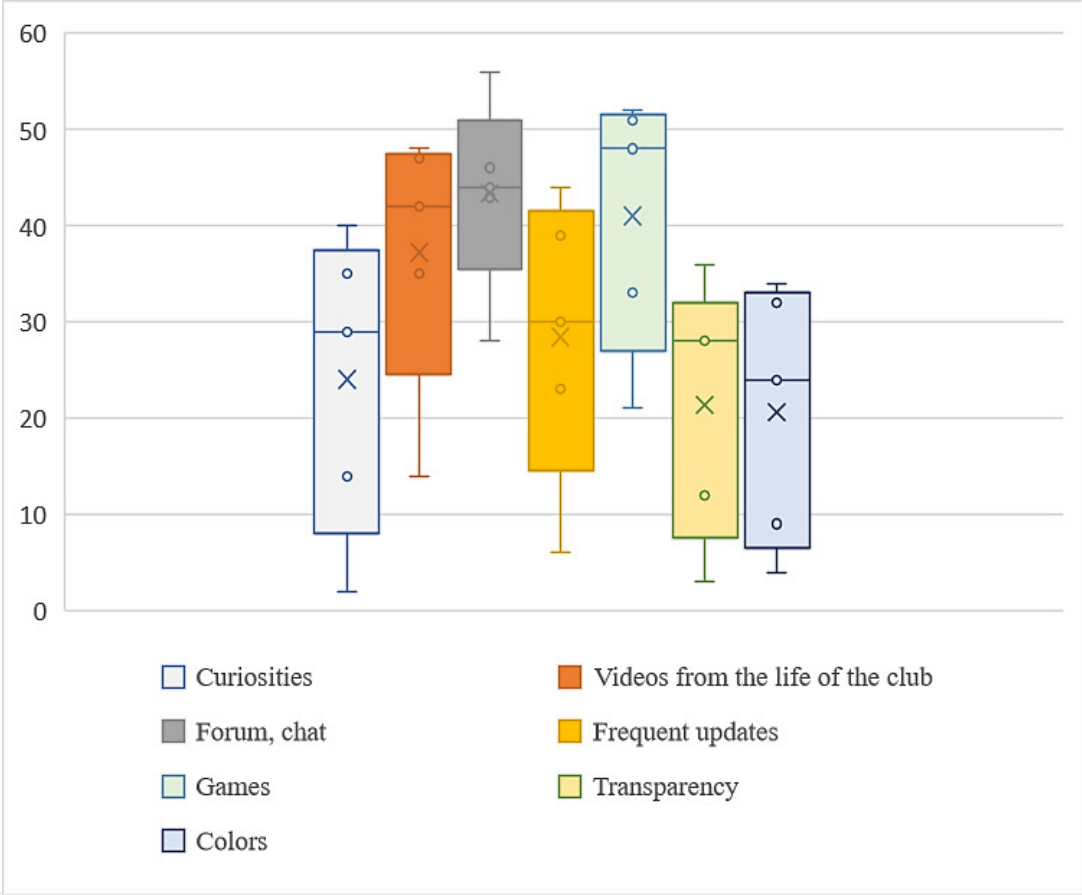

Figure 2. Graphics of assessments of factors influencing the attractiveness of social media.
Source: Own compilation based on data from reaserch.

The graphic in Figure 2 shows a greater variation in scores than in the first part of the study. This is evidenced by a greater spread of means (from 11 to 26.1) and variances (from 40 to 71). However, this is too little to determine whether the factors influencing the perceived attractiveness of social media are statistically differently rated by respondents. Accordingly, calculations were made of the underlying statistical measures, which are presented in Table 2.

In the data of Table 2 in line with the interpretation of the earlier graphic, a relatively large variation is apparent. The mean of the attractiveness ratings ranges from 11.2 to 42.8 and the variance from 40.67 to 98. The factor whose rating differs most from the others is games.

Little variance in the data is apparent here. The coefficients of variation expressed in terms of the ratio of the standard deviation to the mean indicate a wide dispersion of individual ratings (from 29.5% and 33.5% to 58.5%, 58.7% and 56.3%). The variation is smallest for games and greatest for the colour scheme of the site.

Table 1.
User rankings of factors influencing the attractiveness of social media

	Curiosities	**Rangi**	**Videos from the live if the**	**Rank**	**Forum, chat**	**Rank**	**Frequent updates**	**Rank**	**Games**	**Rank**	**Transparency**	**Rank**	**Colors**	**Rank**
I strongly agree	2	1	14	7,5	28	13	6	4	21	9	3	2	4	3
I tend to agree	14	7,5	35	20,5	44	27,5	23	10	51	33	12	6	9	5
I don't have an opinion	29	15	42	25	46	29	30	16	33	18	28	13	24	11
I don't think I agree	35	20,5	48	31,5	56	35	39	23	52	34	28	13	32	17
I strongly disagree	40	24	47	30	43	26	44	27,5	48	31,5	36	22	34	19
Rank summary	**x**	**68**	**x**	**114,5**	**x**	**130,5**	**x**	**80,5**	**x**	**125,5**	**x**	**56**	**x**	**55**
Average	13,6	x	22,9	x	26,1	x	16,1	x	25,1	x	11,2	x	11	x
Standard deviation	8,41	x	8,62	x	7,23	x	8,50	x	9,92	x	6,85	x	6,32	x
Variance	71	x	74	x	52	x	72	x	98	x	47	x	40	x
Coefficient of variation	33,5%	x	58,5%	x	20,6%	x	46,9%	x	29,5%	x	56,3%	x	58,7%	x

Source: Own compilation based on data from reaserch.

As the numbers are not clear and sufficient, the procedure outlined earlier in this article was used.

This led to the following calculations, from the determination of the empirical statistics to the verification of the null hypothesis that all samples (i.e. the factors influencing the post-regression of attractiveness) come from one population, and the alternative hypothesis that not all samples come from one population (being homogeneous or heterogeneous). The figures are again presented to four decimal places.

$$T = \frac{12}{35(35+1)}\ 12631{,}2 - 3\ (35+1) = \ 0{,}0095 * 12631{,}6 - 108 = 12{,}2971 \qquad (5)$$

Again, due to the existence of associated ranks in the distribution, post hoc calculations were performed according to the Dunn test, where the C-index was 0.9994.

$$C = 1 - \frac{24}{42840} = 0{,}9994 \qquad (6)$$

After adjustment, the final empirical value is the product of the T and C coefficients, i.e. it is 12.5912 (12.2971*0.9994). The null hypothesis, stating that regardless of the type of social media, the results are the same (homogeneous), should be rejected when the test statistic is greater than the number defining the critical area with 6 degrees of freedom and an assumed level of significance (0.05). This statistic is 9.5916, so the hypothesis of homogeneity of social media types should be rejected, i.e. the evaluation of the factors influencing the perception of social media attractiveness differ from each other.

The results of the calculations for both groups show the diversity of the groups, both in terms of types of social media and in terms of factors influencing the attractiveness of social media websites.

The research findings are very accessible for social media management in a sports company, although the same procedures may be available in other companies as well. Research has shown that the respondent, i.e. a fan or customer, uses the medium as one of several social communication channels and this assessment differs from the assessments of users of other media. it is an assessment of factors influencing the attractiveness of social profiles. Information such as interesting facts, updates, videos from club life, forum (chat), games, transparency and changes, despite external schemes and the use of benchmarking by clubs, are advisory in the way they are used. This is provided not only by statistical tests, but even by basic indicators such as means, standard deviation, variance and variability indices. When it comes to the fact that the departments target social media, they are not only top-notch but also undifferentiated, this is very important information for them.

In the future, the evaluation of websites, social media and people's online behavior will need to be carefully examined. Large research opportunities provide multivariate analyses, are still available, but also more diverse differentiated influenza or quantitative analyses.

5. Discussion

The conducted research has shown that, thanks to the modified Kruskal-Wallis ANOVA method, it can be determined that there are differences in assessments between the types of individual social media and the factors influencing the perception of their attractiveness. The main aim of the article is to verify the similarity of the use of communication tools on the Internet by speedway sports clubs in Poland. An additional goal is to find differences in the perception of the variety of factors influencing the attractiveness and quality of social media sites. Therefore, it was verified whether the differentiation of the studied groups was statistically justified. These differences are important because they require a different approach to the management of these media. In practice, this means that companies (sports clubs in this

case) should not use the same means of communication on different social media profiles, but differentiate them depending on their type.

Particularly noteworthy in the research is the use of basic research, i.e. the Kruskal-Wallis ANOVA test and adapting it to the existing conditions in sports marketing to be a method for determining the homogeneity of groups within the research community. This is the first case in Poland of using this method in sports marketing, on the example of sports clubs. The presented Kruskal-Wallis ANOVA analysis does not provide an answer to the strength of group differentiation, but the mere statement that groups are not homogeneous is important and constitutes the basis for further research and practical activities.

The basic benefits of using this method affect the operation of marketing departments of sports clubs. If type groups and factors influencing perceptions of attractiveness were included in marketing communications through social media, they might be the same. In practice, this would mean that ten materials alone could be published in all these media, without the need to use, i.e. computer, shortening materials, replacing or sharing content and other activities. However, if groups are intended for each medium, they should be included in enough extensions that the groups being studied are similar to each other.

The main advantages of Kruskal-Wallis ANOVA methods include:

- relative statistical simplicity,
- ability to adapt methods to the conditions of various companies operating on the Internet,
- possibility of using methods in quantitative and qualitative research,
- separation of groups to be analyzed for classification,
- possibility of using and analyzing data from direct research.

The disadvantage of the method is:

- the need to know statistical analysis methods and the ability to interpret them,
- requirement to use statistical programs or applications,
- the need to appropriately adapt the research material to the method.

When using the Kruskal-Wallis ANOVA method, the researcher must have specific goals in mind. Depending on what is to be examined, specific data may be substituted, while maintaining the principles of logic, representativeness and objectivity.

In an era when information has become publicly available, researchers should use various methods to verify their opinions on predetermined topics. When modifying statistical methods, it is relatively easy to find those that will help in the management process at various levels. The article was based on the use of one of the statistical methods. Its use allowed us to determine the direction in which marketing communication in social media should develop. According to these studies and the research of other researchers, there is an increasing tendency to differentiate communication in the media, which requires a completely different, more individual approach to particular types of media and their users.

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MICROBIOLOGICAL QUALITY AND RISK ASSESSMENT OF NON-REGULATED LAKES USED FOR RECREATIONAL AND ECONOMIC PURPOSES

Anita KUKUŁOWICZ[1*], Wiktoria JARONIEC[2]

[1] Gdynia Maritime University; a.kukulowicz@wznj.umg.edu.pl, ORCID: 0000-0002-7520-7992
[2] Gdynia Maritime University; wiktoria.jar.99@gmail.com
* Correspondence author

Purpose: This study aims to assess the microbiological quality and risks associated with non-regulated lakes used for recreational and economic purposes. It highlights the potential risks these lakes pose to public health, especially in terms of waterborne diseases, due to fluctuations in water quality influenced by seasonal variations, human activities, and environmental factors. By evaluating the microbiological contamination levels of lakes that are not part of the formal monitoring system, this research seeks to fill a gap in understanding the risks posed by these bodies of water.
Design/methodology/approach: The research employs a combination of water sample collection and microbiological analysis to determine the contamination levels of *Enterococcus* spp. and *E. coli* in various water samples taken from a non-regulated lake (Wyspowo Lake). The study compares contamination levels in nearshore and lake center areas during different months to assess variability in water quality. Statistical analysis was performed to determine the significance of differences between sampling sites.
Findings: The study found that the water quality in Wyspowo Lake generally met the acceptable bathing water quality standards. However, exceedances of *Enterococcus* spp. counts were recorded, particularly for two shore samples collected in June and five collected in July. Shore samples consistently showed higher bacterial levels than samples collected from the lake center, especially for *Enterococcus* spp. These findings highlight the need for increased monitoring of non-regulated lakes to protect public health.
Research limitations/implications: The study is limited by seasonal sampling and the absence of continuous monitoring. Future research could involve more frequent sampling and explore the effects of local human activities on water quality.
Practical implications: Improved monitoring systems for non-regulated lakes are essential for protecting public health. The study suggests integrating quality and risk management strategies into local monitoring practices.
Social implications: The study has significant social implications as it highlights the potential health risks posed by non-regulated lakes, which are often frequented by local communities for recreational purposes. By improving water quality monitoring and public awareness, the research could contribute to better public health outcomes and foster a culture of responsible recreational use of natural resources. Additionally, it could inform local policy decisions related to water management and environmental health, ultimately enhancing the quality of life for people living near these lakes.

Originality/value: This article provides original insight into the microbiological quality and risk assessment of an unregulated lake. It adds value to this field by addressing the microbiological safety of lakes not covered by official regulatory systems and proposing practical solutions for improving water quality monitoring and risk management. The article is intended for local authorities, environmental health experts, and public health, water management, and environmental policy researchers
Keywords: quality management, risk assessment, microbiological quality, public health, non-regulated lakes.
Category of the paper: research paper.

1. Introduction

Surface water contamination is a significant global challenge, driven by both natural processes and human activities (Vadde et al., 2018). Key contributors to this issue include industrial development, agricultural practices, industrial waste from food production, surface runoff, natural events, and insufficient water supply and wastewater treatment infrastructure. The release of untreated waste into aquatic ecosystems exacerbates water pollution, leading to widespread contamination of water bodies (Lin et al., 2022; Yesilay et al., 2023). The health consequences of water pollution are complex and multifaceted. Exposure to contaminated water can lead to both short-term and long-term health issues, depending on the nature of the contaminants and the level and duration of exposure (Krishan et al., 2023).

1.1. Health risks and the need for effective management of recreational waters

During the swimming season, the primary risk of contracting bacterial, protozoal, and viral gastroenteritis is typically linked to contact with recreational water, rather than food consumption or drinking water. Illnesses associated with recreational water exposure are frequent, with activities such as swimming, paddling, boating, and fishing contributing significantly to annual cases of gastrointestinal, respiratory, and skin, ear, and eye infections (Sanborn, Takaro, 2013; Staley et al., 2013; Russo et al., 2020). Swimmers are estimated to ingest between 10 and 150 mL of water per hour, with children under the age of 10 being particularly vulnerable due to prolonged exposure in shallow, contaminated areas, frequent immersion of the head, and hand-to-mouth contact (Sanborn, Takaro, 2013). The identification of contamination sources and the development of effective management strategies are essential for minimizing public health risks (Lin et al., 2022). Bathing waters host numerous microorganisms, including viruses, bacteria, fungi, algae, protozoa, and their metabolic products. The abundance and species composition of these microorganisms, as well as their activity, are largely influenced by climatic and trophic conditions (Kacprzak, 2019). Swimming in contaminated beach waters significantly increases the risk of skin infections and other illnesses. Pathogenic microorganisms commonly found in polluted water are often the cause of

skin conditions in swimmers. Individuals exposed to bacterial levels above safety thresholds face a significantly higher risk of developing skin diseases. Research indicates that swimmers report skin infections 3.5 times more frequently than non-swimmers (Yau et al., 2009; Lin et al., 2022). Given the intersection of public health, environmental management, and risk management, addressing water quality issues at recreational sites is critical for protecting user health. Moreover, improving quality management practices in water safety is necessary to reduce these risks and safeguard public well-being.

1.2. International guidelines on water quality and risk management

International guidelines, including those from the World Health Organization (WHO) and the European Union, set water quality standards for bathing sites to protect user health through regular monitoring and risk assessment. WHO recommends systematic microbiological testing, with fecal coliforms used as indicators of fecal contamination and overall water quality (Doe et al., 2016). The EU's Bathing Water Directive (Directive 2006/7/EC) emphasizes bathing site profiling and preventive measures to reduce health risks. These guidelines provide a regulatory framework that aids in reducing public health risks through proper water quality management. Together, these standards offer a structured approach to water quality management and risk assessment, improving the overall health protection of recreational water users.

1.3. National water quality management and regulatory framework

The Water Law establishes a water quality management system for bathing areas aimed at enhancing the health safety of bathers and predicting potential hazards. The implementing regulations set standards for water quality monitoring, bathing area profiling, registration and signage of these areas, and outline the authority of the State Sanitary Inspectorate (Kacprzak, 2019; Zwierzyna, 2022). Waters in bathing areas are classified by the State Sanitary Inspectorate based on two microbiological parameters: *Escherichia coli* and intestinal enterococci, in accordance with the provisions of the Minister of Health's Regulation (2019).

1.4. Factors hydrological and ecological profile of the Wejherowo district

Wejherowo district, located in northern Kashubia, is a picturesque area positioned along a major transportation corridor connecting Gdańsk and Szczecin. Situated just a few kilometers in a straight line from the Baltic Sea, over half of the commune's area is part of the Tricity Landscape Park. The entire region falls within the catchment area of rivers flowing into the Baltic, with a well-defined hydrological network. Primary watershed boundaries divide Wejherowo into four river basins: Reda, Piaśnica, Zagórska Struga, and Gizdepka. Beyond its extensive river network, Wejherowo features several scenic lakes, mainly concentrated on the plateau of the Kashubian Lake District near the terminal moraine. These are mostly kettle lakes,

lacking surface outflow, with prominent examples including Wyspowo, Bieszkowice, Zawiat, Borowo, Pałsznik, and Wygoda. Additionally, the commune encompasses ecologically valuable areas protected under various conservation designations, such as the ecological sites "Szuwary Jeziora Wyspowskiego" and "Wyspowska Łąka", underscoring the importance of adhering to protective measures for these natural habitats. (Mieloch-Stojczyk, 2021).

1.5. Research problem and aim of the study

At public bathing sites, the health of individuals using water attractions should be protected through systematic water sampling and the temporary closure of sites that exceed microbial levels specified by regulations. The supervision of bathing sites and areas occasionally used for swimming, particularly regarding water quality management, falls under the responsibility of local sanitary inspectors (Zwierzyna, 2022). However, not all bathing areas are subject to regular microbiological inspections. These inspections are mandatory only at officially registered sites designated as bathing areas by local authorities, whereas sites used occasionally for swimming, lacking official status, are not systematically monitored. This lack of oversight raises a critical health risk management issue: Are users of unmonitored recreational lakes exposed to higher risks of waterborne illnesses? The aim of this study was to evaluate the microbiological safety of a recreational lake that lacks official sanitary controls, addressing the public health risks posed to users and highlighting the need for improved risk management practices in water quality supervision.

2. Material and Method

2.1. Study area

The Wyspowo Lake, located in northern Poland at the edge of the Kashubian Lake District, is a forest-enclosed lake bordered by a large meadow, southeast of Wejherowo near the village of Zbychowo in the Wejherowo commune, Pomeranian Voivodeship, within the Tricity Landscape Park (coordinates: 54°33′33″N 18°18′12″E). Encompassing an area of 23.0 hectares and bordered by a shoreline measuring 1,910 meters, Wyspowo Lake reaches a maximum depth of nearly 5 meters, with an average depth of 2.6 meters. The Cedron River flows through the lake. Primarily serving as a recreational and tourist site for residents of the nearby Small Tricity region (Wejherowo, Reda, Rumia), Wyspowo Lake is especially popular among members of the Rumia Chapter No. 50 of the Polish Angling Association. The area around the lake features seasonal cottages and the village of Wyspowo, part of the Zbychowo district. Nearby, a large forest parking area accommodates numerous camper trailers during the summer season (Jezioro Wyspowo, 2013).

2.2. Research materials and Microbiological analyses

The study material comprised water samples collected from Wyspowo Lake, specifically from nearshore water layers (n = 32) and the lake center (n = 32). Samples were collected in sterile containers from a depth of approximately 0.5 m below the water surface. Immediately after collection, the samples were stored in an insulated cooler at 4±1°C and transported to the laboratory within 2 hours for analysis. Each analysis was performed in four replicates to ensure accuracy and reliability of the results. The traditional plate count method was used for microbiological assays. Sampling procedures followed the Water Law Act of 20 July 2017 (Journal of Laws of 2021, item 624, as amended), which defines the bathing season from 1 June to 30 September. In accordance with the Regulation of the Minister of Health of 17 January 2019 on water quality supervision in bathing and occasionally used bathing sites (Journal of Laws of 2019, item 255), each water sample was analyzed for *Escherichia coli* and *Enterococcus spp.* counts.

Microbiological tests were carried out to determine the number of:

- *Escherichia coli* on Coli ID medium from bioMerieux (incubation at 37°C for 48 h),
- *Enterococcus* spp. on D-coccosel medium from bioMerieux (incubation at 37°C for 48 h).

2.3. Statistical analysis

The normality of the samples was checked using the Shapiro-Wilk test. Differences between groups in bacterial counts for water samples taken from different locations (lake shore and lake center) were tested using the Mann-Whitney U test. The significance level was set at 0.05. The data were processed using Statistica software (StatSoft, Inc.).

3. Results and Discussions

In 2023, the Wejherowo district hosted two designated bathing areas: Lake Wysoka - Wycztok in Kamień and the Lubiatowo Sea Bathing Area located between beach entrances 43 and 44. Additionally, there were four occasional bathing sites organized at scout camps and one publicly accessible occasional bathing area at Lake Zawiat in Bieszkowice. At the Wysoka – Wycztok bathing area, a temporary bloom of blue-green algae was observed at the end of the summer season, while Lake Zawiat experienced a temporary bacteriological contamination before the start of the bathing season. In response to these identified issues and to protect public health, the State District Sanitary Inspector in Wejherowo implemented a temporary bathing ban at these bathing sites until water quality improved (Informacja o stanie..., 2024). Similarly, the analysis of water samples from Wyspowo Lake, which included samples from both

nearshore and lake center locations, revealed that while average microbiological contamination of the water met the required standards for bathing water quality (≤1000 and ≤400 CFU/ 100 mL, respectively), as outlined in the Journal of Laws (2019, item 255), exceedances of the permissible *Enterococcus* spp. count were detected in several samples. These exceedances suggest that the water quality in some areas of the lake may be compromised due to ongoing or episodic sources of contamination. Heavy rainfall in July may increase fecal coliform and enterococci levels, as stormwater runoff introduces fecal-origin bacteria into water bodies, worsening contamination (Staley et al., 2013). Specifically, two shore samples collected in June and five samples collected in July exceeded the permissible limits for *Enterococcus* spp. The highest concentration of Enterococcus spp. recorded was 1200 CFU/100 mL, which is three times the allowable limit, suggesting the potential for long-standing fecal contamination of the water (Stec et al., 2022). No samples exceeded the permissible *E. coli* levels, though one sample collected from the shore in September contained *E. coli* at 800 CFU/100 mL. These results highlight the variability in water quality during different times of the year, especially during months when fewer bathers were present. Although no statistically significant difference was found between the sampling sites (shore vs. lake center) and *E. coli* counts ($z = 1.44$; $p = 0.1507$), a noticeable increase in *E. coli* levels—approximately 50% higher—was observed in the samples collected from the shore (Table 1). However, a statistically significant difference was found between shore and lake center samples regarding *Enterococcus* spp. counts ($z = 2.88$, $p = 0.0040$).

Table 1.
Average microbial content depending on sampling location [cfu/100mL]

Kind of bacteria	Lake shore (LS) n = 32		Center of the lake (CL) n = 32		Z	*p*
	M	SD	M	SD		
E.coli	178.1	171.8	115.6	88.4	1.44	0.1507
Enterococcus	246.9	256.6	93.7	66.9	2.88	0.0040

M - Mean; SD – standard deviation; z (with correction): value of the Mann-Whitney U test statistic with correction; p - significance level.

Source: own studies.

The literature confirms that nearshore waters are typically the most contaminated (Pandey, et al., 2014), as evidenced by the results of this study (Table 1). People bathing in these areas, especially children, are at increased risk of gastrointestinal illness, as they often spend extended periods in the water, playing both in the water and on the sand (Sanborn, Takaro, 2013). According to the World Health Organization, over 50% of deaths caused by water-related diseases are due to bacterial intestinal infections (Lin et al., 2022; Stec et al., 2022). In comparison to July and August, some of the water samples collected in June and September were free from the examined bacteria, which may be attributed to the lower number of bathers during these off-peak months. The risk of illness is determined by both the concentration of pathogens in the water and the level of human interaction with it. Activities that involve close

contact with water, such as swimming or bathing, carry a higher risk compared to those with limited exposure. Water quality standards are primarily established to protect public health during such high-contact recreational activities (Russo et al., 2020; Guidelines on recreational…, 2021). Integrating quality management and risk management principles into monitoring and control systems can enhance the effectiveness of these guidelines, ensuring consistent protection of public health and minimizing exposure to harmful pathogens. Wyspowo Lake, while surrounded by forest and adjacent to a meadow, is also in proximity to seasonal summer cottages and a large forest parking lot that accommodates numerous camping trailers during the summer months. These human activities contribute to the vulnerability of surface waters, which are prone to rapid and significant microbiological quality changes. Such fluctuations often stem from municipal wastewater discharge, agricultural runoff, and rainwater carrying pollutants into water bodies like lakes and rivers, posing risks to their ecological balance and public health (Staley et al., 2013; Stec et al., 2022). Given the increasing risk of microbiological contamination in lakes not covered by the sanitary-epidemiological supervision system, there is an urgent need for regular water quality monitoring in these water bodies. Monitoring such lakes is crucial, especially when they are used for recreational and economic purposes, as it allows for early identification of potential health risks and the implementation of appropriate preventive measures

4. Summary and Conclusions

Based on the findings of this study, it is evident that lakes not covered by the formal monitoring system can still pose significant microbiological risks, especially when used for recreational and economic purposes. Variations in water quality, influenced by seasonal factors, human activities, and environmental conditions, were observed. Despite compliance with regulatory limits on average, exceedances of fecal indicator bacteria, such as *Enterococcus* spp., were detected, particularly in shore samples during months with higher rainfall and increased stormwater runoff. This highlights the importance of monitoring non-regulated lakes to ensure public health safety and mitigate the potential risks of waterborne diseases. Effective integration of quality management and risk management strategies into water quality monitoring systems is essential to protect the health of individuals engaging in recreational activities, particularly in high-contact areas such as nearshore waters. Further research and regular surveillance of these water bodies are crucial to maintaining water safety standards and minimizing public health risks.

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DIFFICULTIES IN OBTAINING DATA FOR THE QUALITY OF LIFE SURVEY PROCESS

Mariusz J. LIGARSKI

Politechnika Śląska, Wydział Organizacji i Zarządzania, Katedra Ekonomii i Informatyki;
mariusz.ligarski@polsl.pl, ORCID: 0000-0002-5754-2324

Purpose: The aim of this paper is to examine how municipal offices acquire data in the quality of life survey process and to highlight the difficulties that arise at this stage.
Design/methodology/approach: A questionnaire survey was carried out on a sample of 29 city halls of over 50,000 inhabitants located in Poland that conduct structured quality of life surveys. Information was obtained on the organization of the data collection process and the difficulties at this stage.
Findings: Factors that influence the correct course of the data acquisition process in quality of life surveys were identified. Particular attention was paid to the frequency of the survey, the definition of indicators and the preparation for the survey. Limitations and problems that arise at the data acquisition stage were identified. A list of six main difficulties that should be taken into account at the planning stage of a quality of life study was developed.
Research limitations/implications: Limitations arising from the specifics of the study are highlighted and directions for further research are suggested.
Practical implications: Solutions have been identified that have practical applications for municipal offices and should improve the data acquisition process.
Social implications: The social implications of the research have been identified. Proper data collection from residents should improve the quality of life.
Originality/value: The paper outlines the importance of proper data acquisition in the quality of life survey process and its impact on subsequent decision-making and action. Attention was paid to the awareness and knowledge of those responsible for conducting quality of life surveys. It analyses the problems that arise at the data acquisition stage and, on this basis, identifies a list of six basic difficulties that should be taken into account when preparing for a survey.
Keywords: Data collection, quality of life survey, municipal office.
Category of the paper: Research paper.

1. Introduction

Nowadays, a city can be treated as a complex system influenced by many elements and the network of relationships between them. A unit composed of many elements, functioning in a specific area, in a specific environment, should be treated as a dynamic, functional whole, i.e. a territorial social system (Chojnicki, 1988). Urban development planning requires knowledge of the individual elements of the city system and the relationships between them, and the adaptation of these assumptions to local conditions (Sneddon et al., 2006). It is therefore not possible to directly replicate solutions taken from other geographical or socio-economic realities. It is necessary to obtain information from the city level, with a particular focus on information from the residents living in the area. This is reflected in the smart city concept and definitions of the concept (Giffinger et al., 2007; Caragliu et al., 2011; Nam, Pardo, 2011; Bakici et al., 2013; Albino et al., 2015; Kubina et al., 2021; Hajek et al., 2022). The most widespread smart city model assumes that six areas are linked, identifying a number of factors in each area (Giffinger et al., 2007). The smart city concept is still evolving and in its third generation, citizens should take the initiative (Alexopoulos et al., 2019; Pira, 2021; Kubina et al., 2021). Residents should provide the information needed and be involved in the development of the city. There are different forms of resident involvement, both individual and collective. The municipal government should create the right conditions for expressing needs and expectations. It should develop methods to collect opinions and comments from citizens. Moreover, these methods should ensure that data is collected in a cyclical manner. Many authors point out the need to obtain information from different sources (Huovila et al., 2016; Bosch et al., 2017; Allam, Newman, 2018; Desdemoustier et al., 2019; Camboim et al., 2019; Jonek-Kowalska, Wolniak, 2023). Adequate acquisition of this information and, later, its proper processing should lead to specific decisions and actions. The concept of bottom-up information transfer has many proponents (Caragliu et al., 2011; Bakici et al., 2013; Albino et al., 2015; Macke et al., 2018; Kubina et al., 2021; Hajek et al., 2022). In contrast, relatively few authors highlight the difficulties and barriers associated with obtaining and processing information from citizens (De Guimarães et al., 2020; Tan, Taeihagh, 2020; Treude, 2021; Mouratidis, 2021). One method of obtaining information from citizens is through quality of life surveys. To date, these surveys have been used to assess the satisfaction of citizens and to evaluate the performance of the city government (Insch, 2010; Macke et al., 2018; Rodríguez Bolívar, 2021). In contrast, they have not been used to obtain information that can be useful for the wider development of the city (Papachristou, Rosas-Casals, 2019; Moeinaddini et al., 2020; Goerlich, Reig, 2021; Mouratidis, 2021; Przybyłowski et al., 2021). The author of the study and his research team conducted extensive research to investigate how cities understand and conduct quality of life surveys so that information useful for sustainable urban development can be extracted. Two stages of research were carried out, the first stage analysed cities that

conduct structured quality of life surveys (Ligarski, 2021; Ligarski, Wolny, 2021a, 2021b). In the second stage, a comparative study of cities with and without structured quality of life surveys was conducted (Ligarski, 2022; Ligarski, Owczarek, 2023, 2024). Based on the results obtained, it was clearly confirmed that quality of life surveys can provide information that can be used for sustainable urban development. For this to happen, however, a proper understanding and preparation of quality of life research is needed. This publication focuses on the issue of data collection in the quality of life survey process. How should the municipality organise the data collection stage so that information useful to the city can be obtained. For the purpose of this paper, some of the results obtained in the second stage of the research procedure were used.

The aim of the paper is to examine how city halls acquire data in the quality of life survey process and to highlight the difficulties that arise at this stage.

2. Methods

When embarking on the research, an attempt was made to cover the largest possible group of municipal offices located in Poland. Ultimately, all city offices in cities with more than 50,000 inhabitants were selected for the study. Thus, the subject of the research are 84 city offices in cities with more than 50,000 inhabitants. A research methodology was developed and hypotheses and research questions were formulated. A research tool was selected - a questionnaire survey was chosen. An original survey form was developed for the research. The form included 30 survey questions and a metric. Closed questions were used, allowing respondents to choose one or more answers, depending on the question. Some of the questions also allowed for other answers - where the respondent could formulate the answer themselves. The anonymity of the research was ensured. At no point did the cities provide information that could unambiguously indicate the name of the city. The surveys in the offices were carried out by an organisation that professionally deals with this type of activity, between November 2021 and January 2022. Out of a population of 84 offices, 80 offices responded, giving a survey return rate of 95.2%. Based on the survey results, the offices were divided into two groups. The first that conducts structured quality of life surveys (29 offices in total) and the second that does not conduct structured quality of life surveys (51 offices in total). For the purposes of this study, part of the survey results for the 29 city offices that conduct structured quality of life surveys were used.

3. Results

In order to examine how city halls obtain data in the process of quality of life surveys, we started by determining the frequency of the survey. The answers to the question of how often surveys are conducted in a city are summarised in Table 1.

Table 1.
Overview of responses to the survey frequency question

Content of the question	Answers	Number of responses	Percentage %	Additional answers – number of indications
How often are quality of life surveys conducted? N = 29	a. annually	10	34.5	
	b. more frequently than annually	0	0	
	c. every two years	12	41.4	
	d. every three years	2	6.9	
	e. less frequently than every three years, please specify frequency of examination	5	17.2	every few years - 2 irregularly - 2 for work on strategic documents - 1

Source: Own study.

More than 41% of surveyed organisations report that quality of life surveys are conducted every two years. Only 34.5% of respondents indicate that surveys are conducted annually. Almost 7% of respondents declare that quality of life surveys are conducted every three years. As many as 17.2% of respondents indicate that surveys are conducted less frequently than every three years. In this group, respondents write that surveys are conducted every few years, irregularly, when strategic documents need to be developed. What picture of the frequency of surveys can be gleaned from the analysis? Quality of life surveys are conducted relatively infrequently in cities. Only 34.5 per cent of respondents declare that surveys are conducted annually. Taking into account the fact that none of the surveyed authorities declared surveys more often than annually, it seems that conducting surveys once a year should be the optimal solution. The city council receives cyclical information on the quality of life in the city and, once it has been properly processed, can use it to make decisions and take action. A period of one year should be sufficient to capture the changes taking place and the perception of phenomena as perceived by the inhabitants of a given community. The Authority thus obtains up-to-date information and is able to follow the phenomena taking place in the city. A quality of life survey conducted every two years may not be sufficient. The city will obtain information too infrequently and will not be able to react to emerging phenomena on an ongoing basis. The passage of two years will result in some data being provided with a long delay and there may no longer be a chance for an appropriate response from the authority. People who participated in the survey without seeing a response to the issues they reported may become discouraged and not participate in the survey in the future. Cities that conduct surveys every three years or less are even worse off. The Authority receives random data from which it will be difficult to obtain reasonable information. The cyclical nature of the provision of information

and the ability to respond to emerging phenomena is disrupted. Thus, the frequency of the quality of life survey has a strong impact on the amount, type and timeliness of the data collected.

The second question surveyed was whether cities specify quality of life indicators in their surveys. Table 2 summarises the answers to the question regarding the definition of indicators, their number and types.

Table 2.
Overview of responses to questions on indicators, their number and types

Content of the question	Answers	Number of responses	Percentage %	Additional answers – number of indications
Have quality of life indicators been identified for your city? N = 29	a. yes	17	58.6	
	b. no	12	41.4	
What number of quality of life indicators have been identified in your city? N = 17	a. under 3	0	0	
	b. between 4 and 6	0	0	
	c. between 7 and 10	2	11.8	
	d. between 11 and 20	2	11.8	
	e. between 21 and 40	7	41.1	
	f. between 41 and 100	6	35.3	
	g. more than 101	0	0	
What kind of indicators are these? N = 17	a. there are indicators but they are not divided into groups	10	58.8	
	b. indicators are divided into soft and hard indicators	0	0	
	c. indicators are divided into objective and subjective	2	11.8	
	d. indicators are divided into simple and integrated	2	11.8	
	e. other, please specify?	3	17.6	indicators correspond to those adopted in the city development strategy - 3

Source: Own study.

58.6% of the surveyed organisations define quality of life indicators and 41.4% do not define any indicators. Defining indicators should make it easier to carry out quality of life surveys and to compare results between survey cycles. Indicators define certain measures, allow certain phenomena to be described. If a city decides to develop indicators, it should analyse the phenomena that occur in it. An appropriate selection of indicators should provide comprehensive information on important phenomena occurring at the city level. Defining indicators is a form of preparation for data collection. If the city defines the indicators for the survey well, it will be able to collect more useful data. It will also be easier to compare the information obtained in subsequent survey cycles. In the organisations surveyed, 58.6% of the cities are developing indicators so they are preparing for data collection. Another issue is determining the number of indicators and the types of indicators. 41.6% of the surveyed cities

do not develop indicators. This does not mean that these cities do not prepare for data collection. There are different ways to collect data and different ways to prepare for data collection. However, the lack of indicators can be a hindrance to data collection and comparison. Seventeen of the twenty-nine cities have defined quality of life indicators. The number of indicators adopted by each city was determined (Table 2). 41.1% of the cities surveyed indicated a number of indicators in the range from 21 to 40 and 35.3% of those surveyed in the range from 41 to 100. Two cities each indicated a range from 7 to 10 and a range from 11 to 20. None of the cities indicated single indicators. The vast majority of cities chose a larger number of indicators. Describing a larger number of indicators should provide more data. Limiting the number of indicators to a small number will require selective selection of issues for analysis. It is difficult to determine what the optimal number of indicators should be. Each city chooses a given number of indicators after analysing the issues it wants to take into account. This is also evidence of preparation for data collection. If this process has been properly carried out, the city should obtain the necessary data for further analysis. The final issue is to determine the type of indicators (Table 2). Most cities (58.8%) do not divide indicators into groups. Two cities each divide the indicators into objective and subjective or simple and integrated. Three cities use a different division, dividing the indicators in such a way that they correspond to the indicators adopted in the city development strategy. In this case, too, it is difficult to speak of a standard way of proceeding. The cities decide individually whether to divide the indicators into groups or not. Either approach can be considered appropriate, provided it is based on a rational assessment of the indicators at hand. Any grouping of indicators can provide the organisation with additional information and allow for grouping of data.

The third question examined was how cities prepare for data collection in terms of the subsequent use of the information. A summary of the answers to the question of whether, when starting to collect quality-of-life data, the person in charge of the research knows what the information will be used for in the future and which organisational units it should go to is summarised in Table 3.

Table 3.
Overview of responses to the question on preparation for data collection

Content of the question	Answers	Number of responses	Percentage %
When you start collecting quality of life data, do you know for what purposes the information will be used in the future and to which organizational units it should go? N = 29	a. definitely no	0	0
	b. rather no	1	3.5
	c. neither yes nor no	1	3.5
	d. rather yes	18	62
	e. definitely yes	9	31

Source: Own study.

Only 31% of respondents answered definitely yes to this question. This means that only one third of the surveyed cities, when preparing to collect data, know exactly what the information obtained from the quality of life survey will be used for in the future. They clearly know the goals of data collection and are aware of which organisational units the processed data should go to. With such knowledge, one can properly prepare for data collection. Identify the issues that should be investigated and refine the questions that will enable the necessary data to be obtained. A data collection preparation process organised in this way should ensure that sufficient data is obtained. This data, when properly processed in the future, should lead to useful information to be used for decision-making and action. The remaining cities declare problems with the preparation for data collection. 62% of the respondents answered rather yes to the question posed. How to interpret such answers? Are cities only partially aware of the purposes of data collection? Do they not fully know which organisational units the processed data should go to? This type of answer contains uncertainty, lack of conviction, doubts. The person in charge of conducting the research does not have full knowledge of what the data will be used for and where it should go. Without such knowledge, it will be difficult for her to prepare for data collection. If he or she makes mistakes or is negligent, it may lead to a situation of obtaining random data from which it will be difficult to obtain the necessary information later. Two of the surveyed cities did not answer affirmatively to the question posed. That is, they declare that when starting to collect data they do not know for what purposes the information is to be used in the future and which organisational units it should go to. If they do not have such knowledge, they will not be able to properly prepare for data collection.

The fourth issue surveyed was to identify what could be improved in data collection. A summary of the responses to the question of what, in the opinion of those responsible for conducting quality of life surveys, could be improved when collecting data is summarised in Table 4.

Table 4.
Overview of responses to the question on opportunities for improvement in data collection

Content of the question	Answers	Number of responses	Percentage %	Additional answers – number of indications
What do you think could be improved in the collection of data on the quality of life in your city? N = 29	a. there is no need for improvement as everything works fine	4	6.8	
	b. clearly define what data is needed	11	18.6	
	c. specify the purposes for which the data will be used	6	10.2	
	d. determine which organisational units and posts the data should reach	4	6.8	
	e. better prepare the data collection process	13	22	
	f. train staff in the purpose and methods of data collection	10	16.9	

Cont. table 4.

	g. hold meetings with the authority's management to explain the purpose and methods of data collection	8	13.6	
	h. other, please specify?	3	5.1	simplify the survey - 1 select a company to carry out the survey - 1 attempt to develop the survey methodology and questionnaire together with other cities - 1

Source: Own study.

In this question, respondents were given the opportunity to select multiple answers. A total of 59 responses were obtained, which shows that respondents tended to indicate several answers. From this, it can be concluded that those responsible for conducting quality of life surveys are aware of the need for change and improvement in the data collection process. Only in 6.8% of the indications it was stated that everything works well and there is no need for improvement. Thus, in a very small number of offices, the data collection process is declared to be functioning properly. In the remaining offices, various difficulties arise at this stage and the investigators try to point out specific solutions that should improve the situation. The most frequently indicated solution (22%) is the recommendation to better prepare the data collection process. The preparation of this process has a decisive impact on the quantity and quality of the data collected. A well-prepared process should allow useful data to be obtained, whereas a poorly prepared process can lead to random data. Thus, if the city does not prepare the process properly, the needed data may not be obtained. The lack or scarcity of needed data will cause serious disruption downstream and necessary decisions and actions may not be taken. The second most frequent answer (18.6%) is to be clear about what data is needed. An authority embarking on a quality of life survey should clearly state what data will be collected and what it is to be used for. If such information is not available, random data not relevant to the authority may be collected. There is a danger here of conducting research for research's sake. Without knowing what data is needed, random data is acquired. Analysis of random data will not lead to useful information. The Authority conducts research but does not obtain the information it needs. The third most common answer (16.9%) is to train staff on the purpose and methods of data collection. The Authority is responsible for preparing the staff who will conduct the quality of life surveys. These people are supposed to understand the purpose of the surveys and know the methods of data collection. If they do not have this awareness and knowledge it will be difficult for them to carry out their tasks properly and this will affect the results of their work. Another indication (13.6%) seems particularly interesting.

It is postulated that a meeting should be organised with the management of the office to explain the purpose and methods of data collection. Preparation for data collection is not only reserved for those who are directly responsible for and implement the process. The top

management of the office should be involved in the process. Firstly to draw attention to the importance of the process and the data collected in it. Secondly, to explain the purpose and process of the process. And thirdly to show that the data obtained, once properly processed, will be used for decision-making by the authority's management. Such an approach should ensure that the quality of life survey has the right prominence in the office and allows the needed communication between the different parties involved in the process. Another indication (10.2%) calls for defining what the data will be used for. In order to define the data well, it is necessary to clearly indicate for which purposes it will be used. These purposes are to be known by those who prepare the data. The next indication (6.8%) is related to the previous one. It is proposed to specify to which organisational units and positions the data should reach. When preparing the data, the employee should be aware of which locations and positions the data should ultimately reach. Knowing at the stage of data preparation what the data is supposed to do and where it is supposed to go should help to better select issues and refine questions. In the question analysed, respondents were given the opportunity to formulate their own answer in the other section (5.1%). There were three suggestions here as to what could be improved in data collection. The first - to simplify the survey, where it is really a matter of clearly identifying the data that is needed and possibly removing redundant questions. The second - make the choice of company to carry out the survey. Here comes the idea of engaging an external organisation to help prepare for the data collection and then carry out the survey itself. Third - try to develop the methodology and questionnaire of the survey together with other cities. The idea is to cooperate with other cities during the preparation phase of data collection to ensure an exchange of experience and mutual assistance.

4. Discussion

The research carried out provided a great deal of information on data collection in the quality of life research process. The important issues at this stage have been identified and reference has been made to the perception of the phenomena taking place here from the perspective of those responsible for conducting the research. By relating the research results obtained to other publications, several regularities can be identified. Many publications highlight the need to obtain information from residents from a variety of sources (Bosch et al., 2017; Allam, Newman, 2018; Desdemoustier et al., 2019). Quality of life surveys can provide valuable information that, when properly processed, can be used for sustainable urban development (Ligarski, Wolny, 2021b; Ligarski, Owczarek, 2024). A prerequisite for obtaining useful information is the proper organisation and preparation of the data acquisition process, which is also confirmed by other publications (Kaklauskas et al., 2018; Macke et al., 2018). The results obtained highlight the limitations and problems associated with obtaining data from

residents, which is in line with the findings of other studies (De Guimarães et al., 2020; Tan, Taeihagh, 2020; Treude, 2021). As a result of the research, it was possible to obtain information on the knowledge and awareness of those responsible for conducting research. Based on the analysis of the research results obtained, an attempt can be made to formulate potential difficulties that may arise in any city office:

1. The involvement of the office management in the data collection process.
2. Selection of an appropriate survey frequency.
3. Selection of indicators and determination of their number.
4. Preparation for data collection.
5. Clearly define what data is needed.
6. Training of staff on the purpose and methods of data collection.

Awareness of these difficulties should make the office better prepared to conduct quality of life surveys and prevent problems from arising at this stage. The involvement of the authority's management seems crucial. It is the management that takes responsibility for the entire data collection process. It defines the aims and objectives of the research to be carried out and identifies the people responsible for the process. The second issue is the appropriate selection of the frequency of the surveys. The survey should be conducted at such a frequency as to obtain the necessary and up-to-date data. In order to gather the necessary information, it is useful to define indicators. These indicators should describe the issues to be surveyed in a way that is understandable to the residents. It is also important to select an appropriate number of indicators to ensure that all issues are addressed. In order to carry out the data collection process properly, good preparation is needed. When starting to collect data, it is necessary to clearly define what data will be needed and for which purposes it will be used. In order for the data collection process to be carried out properly, it is necessary to train staff on the purpose and methods of data collection. In conclusion, a recommendation can be offered to those responsible for conducting quality of life surveys:

1. Inform and cooperate with the municipal management at the survey planning stage.
2. Conduct quality of life surveys annually.
3. When preparing the surveys, identify the indicators and adapt the number of indicators to the needs of the municipality.
4. Prepare for each survey cycle.
5. Clearly define the data needed.
6. Organise training for staff on the objectives and methods of data collection.

5. Summary

The survey research carried out on a sample of 29 cities that conduct structured quality of life surveys provided interesting information on data acquisition. City halls conduct surveys with varying frequency. The frequency of surveys has a significant impact on the quantity and quality of data obtained. It seems that the solution to ensure access to an adequate database is to conduct quality of life surveys annually. Authorities that conduct surveys less frequently are themselves condemned to a shortage of the necessary data. In most surveyed cities, quality-of-life indicators are defined and a number of them are selected. Sometimes indicators are divided into groups. The definition of indicators is a form of preparation for data collection. If a city has indicators, in a reasonable number, it will be easier for it to collect the necessary information and compare them in subsequent survey cycles. In the research conducted, attention was paid to the awareness and knowledge of those responsible for conducting quality of life surveys. The majority of those surveyed did not explicitly confirm that, when embarking on data collection, they know for what purposes the information will be used in the future and to which organisational units it should go. This raises the issue of inadequate preparation for data collection. If the person entering the survey does not have the necessary knowledge, it will be difficult for him or her to properly prepare for the survey and identify the issues that should be investigated. This, in turn, may lead to a failure to obtain the needed data. The research found that those responsible for conducting quality of life surveys are aware of the need for change and improvement in the data collection process. They most often indicate the need to better prepare the process and to be clear about what data is needed. They call for training of staff on the purpose and methods of data collection and involvement of the office management in the preparation for the surveys. They also draw attention to defining for which purposes the data will be used and to which organisational units and positions the data should reach. On this basis, it can be concluded that there are problems in the offices related to the proper acquisition of data. These problems are noticed by those appointed to conduct quality of life surveys and these people are able to propose measures aimed at removing these problems.

The research results obtained highlight the limitations and problems associated with obtaining data from residents. By analysing the results of the research, it has been possible to identify a list of six basic difficulties that should be taken into account at the planning and preparation stage of data collection in each town hall. Recognising these difficulties provides an opportunity to better organise the data collection process and prevent problems from arising in the process. Good preparation for data collection should result in an adequate amount of useful data. The municipality will then have data which, when properly analysed, can be used to make decisions and take action.

Finally, it is important to signal the limitations of the research. A survey was conducted on a sample of people responsible for conducting quality of life surveys. Thus, the persons surveyed were designated persons who represent the respective city council. It seems advisable to carry out further surveys in the offices. Surveys of city department heads have been planned and this should provide complementary information.

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THE IMPACT OF THE COVID-19 VIRUS ON THE ECONOMIC SITUATION OF ENTERPRISES IN EU COUNTRIES

Lidia LUTY[1], Monika ZIOŁO[2], Dagmara ZUZEK[3*]

[1] Department of Statistics and Social Policy, University of Agriculture in Krakow; lidia.luty@urk.edu.pl, ORCID: 0000-0001-8250-8331
[2] Department of Statistics and Social Policy, University of Agriculture in Krakow; monika.ziolo@urk.edu.pl, ORCID: 0000-0003-0884-4083
[3] Department of Statistics and Social Policy, University of Agriculture in Krakow; dagmara.zuzek@urk.edu.pl, ORCID: 0000-0002-7620-1621
* Correspondence author

Purpose: The aim of this article is to present the diversity of EU countries in terms of the economic situation of enterprises, characterised by key indicators describing, among other things, turnover per employee, employment growth and investment growth per employee. In addition to presenting the differentiation of EU countries in terms of the economic situation of enterprises, the dynamics of change of the selected indicators in 2020 compared to 2015 and in 2015 compared to 2010 are also presented.
Methodology: The economic situation of enterprises in EU countries was assessed using annual data from 2010 to 2020. Increase rates were used to describe the time series. In a second step, EU countries were classified by the economic situation of enterprises using a synthetic variable.
Findings: Based on the results obtained, it can be seen that the country with the highest investment per worker in recent years is Ireland, which has the most favorable values of the analyzed indicators and is in the first position in the ranking. Ireland's economy is characterized by significant foreign investment in the booming technology sector. However Germany, thanks to its strong economy, regularly increases its investment per employee, which supports its long-term growth. Lithuania has also recorded a significant increase in investment per employee, which may be due to the country's dynamic economic development.
Countries with relatively low labour costs, such as Poland and Slovakia, are dominated by industrial sectors where the share of labour costs (W_3 and W_4) is relatively low compared to the value of production. In contrast, in countries such as Austria and France, high labour costs, extensive social systems and more labour-intensive sectors make personnel costs a larger share of total production costs. The transition to remote working caused by the COVID-19 pandemic meant a reduction in employment, automation and digitisation of business processes, which negatively affected the value of W_5 in 25 of the 27 countries analysed and caused a reduction in employment in these countries.
The COVID-19 pandemic has had a diverse impact on businesses in the EU. Although many companies struggled with the crisis and the decline in turnover and the need to reduce staff, some sectors managed to adapt and even develop. In the long term, the pandemic accelerated digital transformation processes and the need to invest in the automation.

Originality/value: The impact of the Covid 19 pandemic on employment has been of great importance. Therefore, an innovative approach to analyzing this issue becomes essential for current and future research in this area. This is confirmed by the presented research.
Keywords: economic indicator, UE countries, personnel cost.
Category of the paper: research paper.

1. Introduction

The COVID-19 pandemic has had a significant impact on businesses in European Union countries, leading to numerous changes in economic activity, the labour market and production structures **(**Lopez-Garcia, Szörfi, 2021; Żak, Garncarz, 2020; Privara,2022**).** As a result of lockdowns, border closures and restrictions on international trade, many businesses, particularly in sectors such as tourism, catering, transport and retail, experienced a drastic drop in turnover **(**Meyermans, Rutkauskas, Simons, 2021; Bloom, Brynjolfsson, Davis, Mizen, 2021**)**. Countries heavily dependent on tourism, such as Spain and Italy, have suffered the most. Turnover per person employed in these sectors fell significantly, which meant a reduction in revenue per employee.

The COVID-19 pandemic has significantly affected turnover and thus turnover per person employed in companies in EU countries. Many industries, especially tourism, retail and services, experienced declines in turnover per employee due to lockdowns and business restrictions. Countries such as Spain, Italy and Belgium have seen declines in this indicator as a result of business closures and reduced demand. Nevertheless, some countries, such as Germany, remained stable due to better economic conditions.

The pandemic has also caused liquidity problems for many companies, especially in the small and medium-sized enterprise (SME) sector (Fana, Tolan, Torrejón, Urzi Brancati, Fernández-Macías, 2020; Hamann, Niebuhr, Roth, Sieglen, 2023; Sapir, 2020) Declining demand and difficulties in raising investment capital have resulted in reduced investment. Companies have had to delay or abandon planned investment projects, negatively affecting their long-term growth.

In response to the pandemic, many companies have had to adapt their procedures, increasing operational costs. Examples include costs associated with complying with new hygiene standards, the introduction of remote working and the reorganization of supply chains. Companies have also had to adapt to changing national health and safety regulations. The pandemic has resulted in redundancies and job cuts in many sectors.

Frims have been reducing the number of employees in response to reduced demand. At the same time, there has been a surge in flexible working arrangements, such as remote working, which has affected the structure of employment in the EU. Sectors related to information technology and services have been able to adapt more quickly to this change, while other, more traditional sectors, have found it more difficult.

In response to the pandemic crisis, many companies have accelerated their digitalization processes, investing in technologies related to e-commerce, remote working tools and automation.

Companies began to look for more local suppliers and to invest in technology that would enable greater automation and independence from global disruptions to international trade. Sectors such as technology, e-commerce and pharmaceuticals have seen increases, while others such as tourism, air transport and catering have experienced the biggest declines. In countries such as France, Croatia, Spain and Italy, where tourism is an important part of the economy, the pandemic caused severe difficulties, while in technologically strong countries such as Luxembourg, Sweden and Ireland, the impact was milder.

2. Materials and Methods

An assessment of the economic situation of enterprises in EU countries was carried out using annual data from 2010, 2015, 2020. Six indicators were selected for analysis (Table 1).

Table 1.
Indicators describing the economic situation of companies in EU countries

Variable	Full name
W_1	Turnover per person employed [thousand €]
W_2	Gross value added per employee [thousand €]
W_3	Share of personnel costs in production [%]
W_4	Average personnel costs (personnel costs per employee) [thousand €]
W_5	Growth rate of employment [%]
W_6	Investment per person employed [thousand €]

Source: Own study based on Eurostat. Available online: https://ec.europa.eu/Eurostat, 15 October 2024.

Their selection was preceded by a literature review, data availability and statistical analysis (Table 2).

Table 2.
Basic numerical characteristics of indicators of the economic situation of enterprises in EU countries

Variable	2010				2015				2020			
	min	max	mean	CV*	min	max	mean	CV*	min	max	mean	CV*
W_1	48,60	501,50	171,79	62,98	63,40	591,60	188,40	65,31	77,30	569,40	194,57	64,37
W_2	9,70	92,80	45,91	56,05	13,70	153,40	51,03	62,79	20,10	197,90	57,28	66,62
W_3	13,30	30,30	19,88	22,60	13,20	26,40	19,64	19,76	10,00	28,10	21,34	18,95
W_4	4,50	49,50	26,26	59,38	6,50	55,60	28,00	58,66	10,10	62,50	31,02	52,59
W_5	-6,80	6,10	-1,71	184,71	-9,00	6,70	1,64	191,19	-6,80	2,10	-2,50	79,78
W_6	3,40	22,30	8,15	53,00	3,20	20,60	8,66	53,47	2,90	25,80	9,00	57,20

*CV – coefficient of variation.

Source: Own study based on Eurostat. available online: https://ec.europa.eu/Eurostat, 15 October 2024.

The greatest coefficient of variation between presented EU countries over the analysed period was in terms of the growth rate of employment (Table 2). In 2020, the coefficient of variation for this characteristic was at 79.78% and was much lower compared to 2015 and 2010. A large impact on such a change was due to the COVID-19 pandemic, which caused a reduction in employment in many sectors especially tourism. Another indicator that significantly differentiated EU countries was gross value added per employee. In this case, the coefficient of variation in 2020 was 66.62%.

A synthetic indicator for assessing the economic situation of enterprises in EU countries for each country in each surveyed year was determined according to the formula (Hellwig, 1968)

$$Q_i = 1 - \frac{d_i^+}{d_0} \tag{1}$$

where:

$$d_i^+ = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_j^+)^2} \tag{2}$$

$$d_0 = \overline{d} + 2S_d \tag{3}$$

where:

Q_i - synthetic indicator for assessing the development of the i-country;

$z_{ij} = \begin{cases} \dfrac{w_{ij} - \overline{w}_j}{S_j}, & W_j - stymulant \\ \dfrac{\overline{w}_j - w_{ij}}{S_j}, & W_j - destymulant \end{cases}$ - normalized value *j*-synthetic indicator for assessing the development of the *i*-th country;

$z_j^+ := \max_i \{ z_{ij} \}$;

$\overline{d}, S_d$ - the arithmetic mean and standard deviation of the vector coordinates, respectively $d = \left[d_1^+ \quad d_2^+ \quad \ldots \quad d_n^+\right]$.

The highest value Q_i indicates the best object in terms of the phenomenon under study. Correlation analysis was carried out using the Pearson correlation coefficient.

The values of the synthetic measure made it possible to divide the studied objects into groups according to the following rules:

- group I (very high level): $Q_i \in \left(\overline{Q} + S_Q; \max_i Q_i\right]$,
- group II (high level): $Q_i \in \left(\overline{Q}; \overline{Q} + S_Q\right]$,
- group III (medium level): $Q_i \in \left(\overline{Q} - S_Q; \overline{Q}\right]$,
- group IV (low level): $Q_i \in \left[\min_i Q_i; \overline{Q} - S_Q\right]$,

where $\overline{d}, S_d$ - the arithmetic mean and standard deviation of the values, respectively Q_i defined by formula (1).

Correlation analysis was performed using Pearson's linear correlation coefficient.

3. Results

Indicators: W_1, W_2 and W_6 and are stimulants, the remaining indicators are destimulants, hence the rankings of countries by indicator values in 2020 shown in Figure 1 are in ascending or descending order.

European Union countries varied widely in terms of turnover per person employed (W_1). The highest values of turnover per person employed occurred in Luxembourg and Ireland in 2020, at EUR 569 000 and EUR 528 000 respectively (Fig. 1). The situation is much worse in Croatia and Bulgaria where the lowest values of this indicator were observed at EUR 80 000 and EUR 77 000 respectively. Luxembourg and Ireland have highly developed high value-added sectors such as finance, technology and corporate services. These industries are capital-intensive rather than labour-intensive, which means that the value produced per employee is much higher than in more traditional sectors such as industry or agriculture.

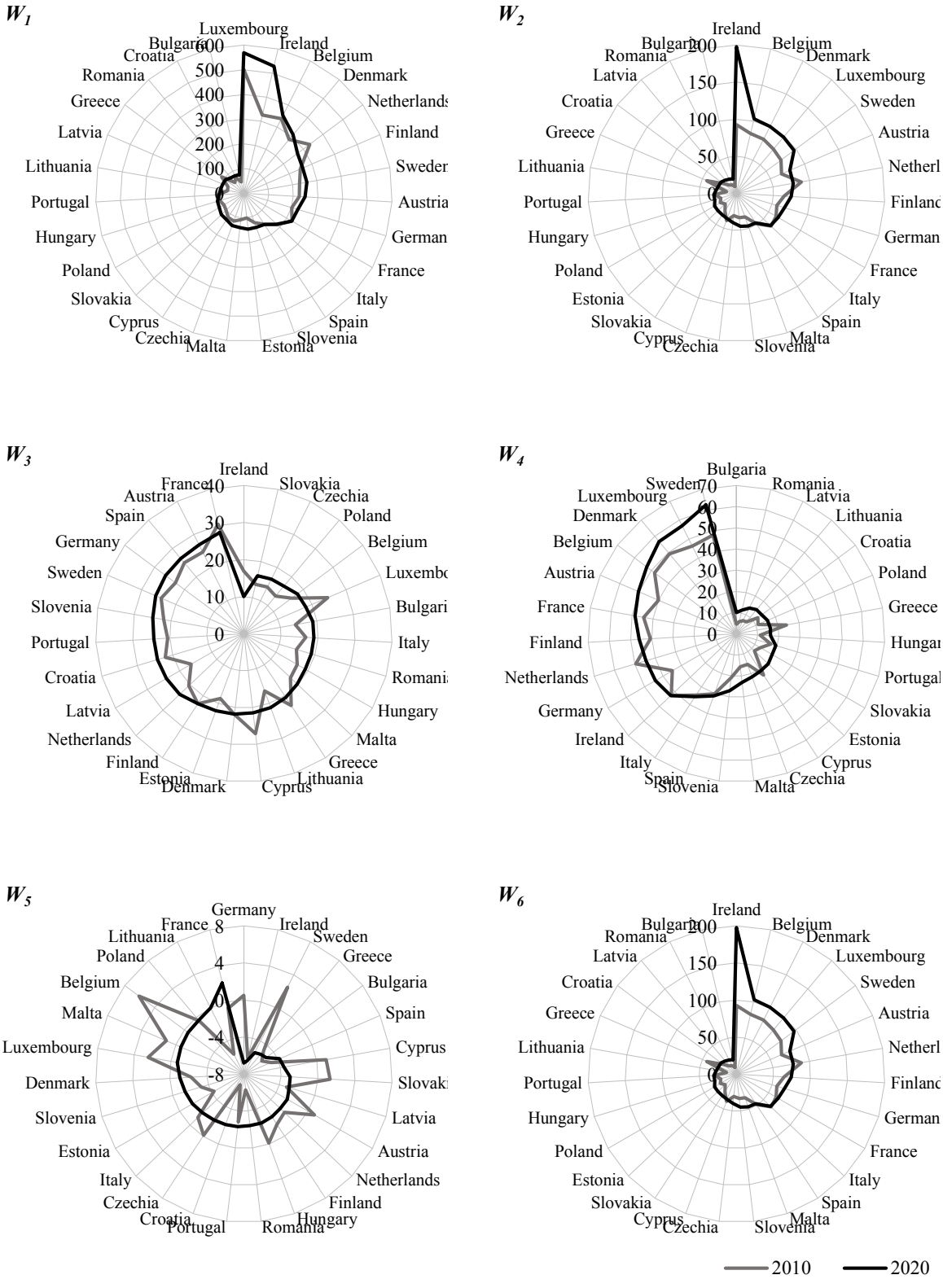

Figure 1. Rankings of EU countries by indicator values in 2020 with 2010 values given.

Source: Own study based on designations as in Table 1.

Another factor contributing to this result is the presence in Ireland of companies such as Apple, Google and Facebook, which significantly increases the turnover per employee ratio. Luxembourg, on the other hand, is dominated by companies in the financial sector, as well as the headquarters of international investment funds, leading to a high turnover per employee. Both Luxembourg and Ireland are known for their favorable tax conditions, which attracts multinational corporations.

The flow of large capital flows through these economies contributes to the high turnover generated per worker. The economies of Bulgaria and Croatia are still dominated by lower value-added sectors such as agriculture, tourism and light industry. Differences in the level of human capital and the conditions for doing business contribute to the limited ability to generate higher turnover per employee.

The gross value added per employee (W_2) indicator obtained the highest values for Ireland and the Benelux countries. The differences in the level of gross value added per employee between countries such as Ireland (€197,000) and Belgium (€103,000) and Romania (€21,000) and Bulgaria (€20,000) are due to different levels of economic development, the structure of the economy, the level of technological advancement and the amount of investment in human capital.

The indicator share of personnel costs in production (W_3) shows what percentage of a country's production costs are wages and other labour costs. The values of this indicator are important for the competitiveness of the economy, as they affect production costs and thus the competitiveness of companies on international markets. In 2020, the lowest values of the indicator were recorded in Ireland (10%), Slovakia (16.1%) and Poland (16.8%). In Poland and Slovakia, foreign companies play a significant role in the economy as they intend to reduce costs by relocating production to these countries. Low labour costs, combined with relatively high productivity, mean that the share of labour costs in production costs remains low. For countries such as Austria (26.9%) and France (28.1%), the share of labour costs in production is much higher. The Austrian and French economies are largely based on labour-intensive sectors such as manufacturing, construction or public services. In such sectors, labour costs account for a significant proportion of total business costs.

Average personnel costs (W_4) were highest in Western European countries such as Austria (€50,000), Belgium (€50,000), Denmark (€53,000), Luxembourg (€ 7,000) and lowest in Eastern European countries such as Bulgaria (€10,000), Romania (€11,000), Lithuania (€13,000) and Latvia (€14,000), the main reason being differences in labour costs.

Growth rate of employment (W_5), in 25 out of the 27 countries analysed, decreased, which is the result of introducing new technologies, besides the COVID-19 pandemic and the related economic consequences are also an important factor. The employment rate fell in Germany (by 6.8%), Ireland (by 6.5%), Sweden (by 5.4%). The introduction of lockdowns, business closures, restrictions in international trade and the service sector have led to mass layoffs, halted

recruitment and a reduction in the number of available jobs. Sectors such as tourism, catering, transport as well as retail were hit the hardest, contributing to the sharp decline in employment.

The Investment per person employed indicator (W_6) measures the amount of investment per employee. High values of this indicator mean that companies are investing heavily in infrastructure development, modern technologies, training and upgrading the skills of employees. This is an important indicator that directly affects productivity and the long-term competitiveness of the economy. In 2020, the highest values of the investment per employee indicator were recorded in Ireland (€25,800), Belgium (€19,100) and Sweden (€15,400). Companies in the finance and new technology sectors which are leading in these countries are required to continuously invest in new technologies and human capital to remain competitive.

In Bulgaria (€4900), Malta (€4500) and Cyprus (€4100), labour costs are relatively low, limiting the pressure to invest in automation and modern technology. Low wages mean that companies have weaker incentive to invest in human capital and technology, as the cost of employment remains low.

Table 3.

Increases in indicators of the economic situation of companies in EU countries 2005-2010 (a) and 2020-2015 (b)

Country	W_1		W_2		W_3		W_4		W_5		W_6	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Austria	13,7	9,8	6,1	6,4	0,6	1,6	5,2	5,1	0,0	-3,4	-0,7	1,1
Belgium	18,8	-4,8	11,4	8,7	1,2	0,7	4,3	0,4	-5,2	-1,4	1,2	1,1
Bulgaria	14,8	13,9	4,0	6,4	1,1	3,7	2,0	3,6	6,8	-6,2	0,4	1,1
Croatia	5,9	1,6	1,2	2,3	-0,8	3,0	0,0	2,3	5,8	-1,2	0,3	-0,6
Cyprus	2,1	9,4	-3,4	0,5	-2,4	-3,2	-2,8	0,4	2,7	-7,3	-4,1	0,9
Czechia	4,8	14,7	2,6	7,0	-0,4	2,8	0,5	5,7	2,3	-4,3	0,0	1,3
Denmark	3,0	22,3	4,9	14,5	-0,6	0,5	1,0	6,6	4,0	-2,8	2,3	-2,4
Estonia	22,5	23,0	6,0	7,5	1,5	2,0	3,7	5,3	5,8	-3,1	2,5	0,2
Finland	3,2	8,0	3,1	6,2	0,5	-0,5	3,8	1,6	0,2	-1,2	3,1	0,9
France	22,7	-24,0	6,6	-3,7	-3,9	1,7	5,9	-1,8	-5,1	7,9	0,9	0,5
Germany	12,0	14,0	3,5	7,1	1,2	2,1	3,9	5,4	0,6	-7,9	0,6	1,9
Greece	-3,6	-15,3	-10,5	-7,1	-4,3	1,7	-5,6	-2,2	-4,3	3,8	-1,2	-1,3
Hungary	5,3	4,9	2,6	5,9	0,1	2,4	0,9	4,1	5,1	-7,4	1,3	2,1
Ireland	129,2	74,1	60,6	44,5	-3,7	-3,2	3,2	-2,9	11,6	-11,9	-1,7	5,2
Italy	17,9	-21,1	2,5	-3,6	1,1	1,1	2,1	-1,3	1,7	-2,4	-2,7	0,0
Latvia	10,5	12,2	3,2	5,4	3,4	4,3	2,5	4,1	5,4	-5,1	0,3	1,1
Lithuania	12,3	16,0	5,4	8,5	1,8	3,0	2,4	5,0	8,3	-2,7	1,4	0,7
Luxembourg	90,1	-22,2	14,6	6,7	-4,8	-1,6	6,3	4,4	0,1	-3,3	4,6	-0,8
Malta	31,1	0,8	10,9	2,0	-0,6	3,1	2,9	4,5	5,6	-7,3	2,5	-6,4
Netherlands	-73,2	12,0	-18,5	7,7	0,1	3,3	-10,6	5,6	4,5	-5,1	-0,9	1,2
Poland	13,6	8,3	2,3	6,6	1,6	1,9	1,6	3,2	3,3	-3,2	1,4	0,1
Portugal	1,6	-3,7	0,5	0,9	0,4	3,3	0,4	2,0	6,5	-6,0	-0,5	0,6
Romania	10,5	14,5	1,5	6,9	0,8	3,4	1,7	3,8	8,0	-4,1	1,7	-0,4
Slovakia	21,0	4,8	0,9	5,4	-0,3	2,7	1,8	4,6	2,7	-7,0	0,3	-0,2
Slovenia	14,9	5,4	5,2	6,5	-0,5	3,5	1,7	4,6	5,3	-3,5	-0,8	0,7
Spain	12,3	-10,1	1,5	-2,8	-0,8	2,3	0,6	0,4	9,1	-8,1	-0,9	0,0
Sweden	31,4	-1,9	9,7	12,2	1,3	0,3	7,7	6,9	-0,5	-7,4	2,6	0,6

Source: Own study based on designations as in Table 1.

The analysis of indicators W_1 to W_6 carried out for the European Union countries in 2015 and 2020 shows significant differences in the dynamics of economic development between countries. The selected indicators show changes in areas such as average turnover generated per employee, gross value added, the share of personnel costs in the value of production or the value of investment per person employed.

Between 2010 and 2015, Ireland, Luxembourg and Sweden recorded the highest increases in turnover per employee. Ireland stands out with the highest growth at €129,200, reflecting the success of the Irish economy, based on foreign investment and characterized by a growing share of the technology sector in total output.

Between 2015 and 2020, countries such as Denmark and Estonia recorded gains of between €22,000 and €24,000. Ireland in particular stood out with an increase of €74,000, which may indicate significant improvements in labour efficiency in these countries.

On the other hand, France, Italy and Luxembourg showed the largest decreases. In France, this was a change of €24,000, which may be the result of structural changes in the country's economy and also the COVID-19 pandemic. Italy and Luxembourg also recorded decreases of €22,200 and €21,100 respectively between 2015 and 2020, reflecting the challenges of the COVID-19 pandemic and the global economic downturn.

Ireland also recorded significant increases in gross value added per employee (W_2) between 2010-2015 and 2015-2020. The performance of the economy in Ireland significantly outperforms other EU countries and indicates that it is one of the most dynamically developing economies in the EU countries. A favourable trend was also observed in Denmark and Sweden where the companies benefited from technological innovation and increasing labour productivity where gross value added per employee increased by €14,500 and €12,200 respectively. In Greece, France, Spain and Italy, 2020 gross value added per employee decreased compared to 2015, which may have been caused by the pandemic crisis as well as the global economic slowdown and a significant reduction in tourist arrivals.

The share of personnel costs in production (W_3) increased significantly in Latvia, Lithuania and Poland in 2015 compared to 2010, which is mainly a result of rising wages and improved working conditions in these countries. These increases suggest that labour costs are starting to play a greater role in the economy, which could affect the structure of production costs.

Reductions in the share of employment costs in total production costs were observed in Luxembourg (-4.8%), Greece (-4.3%), France (-3.9%) and Ireland (-3.7%). Between 2015 and 2020, Latvia, Bulgaria, Slovenia and Romania recorded the largest increases in the range of 4.3% to 3.4%, mainly reflecting the cost of rising wages. On the other hand, Ireland, Luxembourg and Cyprus had relatively low increases or even decreases, which may reflect the stabilization of labor costs.

The increase in average personnel costs (W_4) between 2010 and 2015 was highest in Sweden, Luxembourg and France, which was mainly related to increases in employee welfare packages. Average personnel costs increased by €7700 in Sweden and €5900 in France,

respectively. The high increases in personnel costs may indicate improvements in working conditions and the attraction of skilled workforce.

Between 2015 and 2020, the largest increases in average personnel costs were recorded in Sweden, Denmark, and the Czech Republic. which shows that some EU countries continued to invest in increasing wages or extending social packages for employees. Ireland, Greece and France showed the largest decreases in average personnel costs as a result of the financial crises, which forced these countries to cut budgets and reduce labour costs. Low wages in Bulgaria, Malta and Cyprus mean that companies have less incentive to invest in human capital and technology as the cost of employment remains low.

Employment decreased in 25 out of 27 countries in 2020 compared to 2015. The largest decreases were observed in Ireland (-11.9%), Spain (-8.1%) and Germany (-7.9%), which was probably a result of the reduction in employment due to the pandemic.

The pandemic also affected investment per worker (W_6) especially in countries that rely heavily on tourism. Investment was reduced the most in Malta and this was a decrease of -6.4% in Greece there was a decrease of (-1.3%) in Croatia (-0.6%). In Spain and Italy, investment was unchanged.

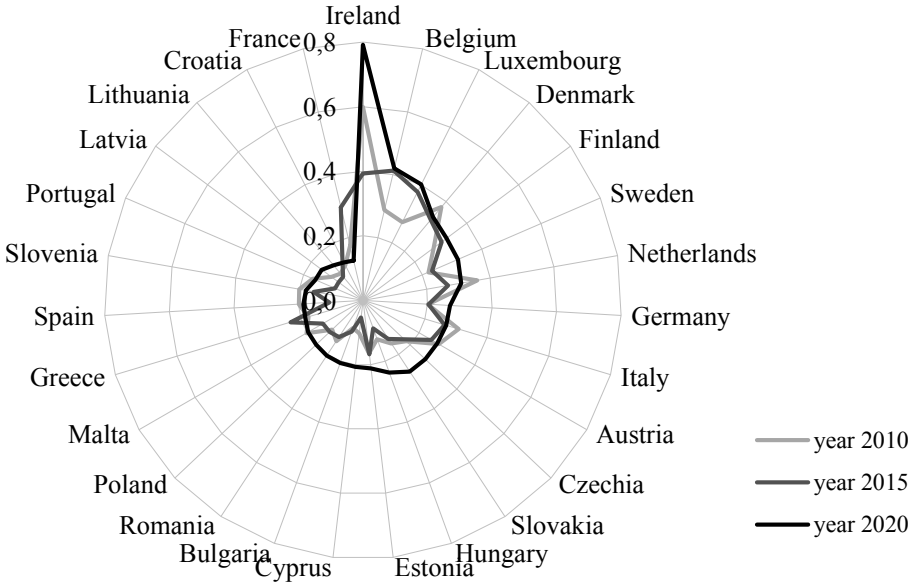

Figure 2. Rankings of EU countries by indicator value Q_i in 2020 with values in 2010, 2015, 2020 given.

Source: Own study based on Eurostat.

Ireland was ranked highest in 2020, ranking first in terms of the synthetic measure throughout the 2010-2020 analysis period. This was followed by the Benelux and Scandinavian countries. The top-ranked countries predominantly base their economies on new technologies and process automation, which largely reduces labour-related costs and determines investment in new technologies. Compared to 2010, 13 countries have improved their ranking.

The most positive developments were in Bulgaria and Cyprus, which moved up 11 places from 27th to 16th and 26th to 15th respectively, reflecting positive developments in the areas of increasing turnover, reducing staff costs and increasing investment. France and Slovenia worsened their ranking by 10 positions during the period under review, indicating a decrease in the efficiency of these economies.

Table 4.
Pearson correlation coefficients between indicators showing the economic situation of companies in EU countries in 2020 and the increments of these indicators

Specification	**Year 2020**						Q	
	W_1	W_2	W_3	W_4	W_5		Year 2010	Year 2015
W_2	0,904					Year 2015	0,788	
W_3	-0,265	-0,287				Year 2020	0,872	0,714
W_4	0,798	0,769	0,213					
W_5	-0,050	-0,209	0,099	0,015				
W_6	0,864	0,934	-0,249	0,755	-0,102			

Source: Own study based on designations as in Table 1.

The indicators for assessing the economic situation of enterprises in EU countries in 2010, 2015, 2020 show a strong correlation (Table 4), hence the grouping of EU countries was made on the basis of the indicator in the last year studied, i.e. 2020. A strong correlation of more than 0.7, was observed between indicators W_1 and W_4 and W_6. And also between W_2 and W_4 and W_6 and W_4 and W_6.

Table 5.
Selected characteristics of indicators in groups of EU member states

Specification			W_1	W_2	W_3	W_4	W_5	W_6
	Ireland							
group		value	528,70	197,90	10,00	42,60	-6,50	25,80
group I	Belgium, Luxembourg, Denmark, Finland, Sweden							
		min	258,70	73,90	18,00	46,00	-5,40	11,90
		max	569,40	103,10	25,90	62,50	-0,50	19,10
		mean	350,02	94,80	21,30	55,04	-2,04	14,80
group II	Netherlands, Germany, Italy, Austria, Czechia, Slovakia							
		min	124,90	34,60	16,10	19,50	-6,80	5,90
		max	270,60	78,60	26,90	50,30	-1,90	12,70
		mean	198,58	60,30	21,42	35,93	-3,17	8,67
group III	Hungary, Estonia, Cyprus, Bulgaria, Romania, Poland, Malta, Greece, Spain, Slovenia							
		min	77,30	20,10	16,80	10,10	-5,20	2,90
		max	151,00	47,60	26,50	31,20	-0,40	7,90
		mean	119,02	34,13	20,92	19,28	-2,64	5,70
group IV	Portugal, Latvia, Lithuania, Croatia, France							
		min	80,10	23,30	21,20	13,60	-2,90	4,40
		max	223,50	64,80	28,10	48,60	2,10	12,80
		mean	118,56	34,30	24,40	22,26	-1,06	6,86

Source: Own study based on designations as in Table 1.

Ireland was ranked highest in 2020, with a much higher score for its business situation than the other countries, so the grouping was carried out excluding this country. The Benelux and Scandinavian countries with the highest turnover per employee and investment per employee were classified in group I.

Group II, where 5 countries are classified, is characterised by the lowest employment reduction rates. The COVID-19 pandemic had a very negative impact on the economies of these countries and companies in these countries were forced to reduce employment even though these countries had the lowest minimum, maximum and average values of costs related to the employment of workers.

The 10 countries with the lowest turnover and investment per person employed were in group III.

Group IV had the lowest average labour costs and the most favourable characteristics describing the growth rate of employment.

4. Conclusion

Analysis of indicators W_1-W_6 confirms the strong economic divergence between EU countries. Countries with stable economic foundations, such as Ireland, Germany or Lithuania, have been able to continue their growth despite global challenges. In contrast, countries struggling with structural problems and economic crises, such as Greece, Spain or Italy, have experienced declines in a number of key indicators, which may require further reforms and a review of these countries' economic policies and especially investment decisions.

The discrepancies in the turnover per employee index between countries such as Luxembourg and Ireland and Croatia and Bulgaria are the result of differences in the structure of the economy, the level of technological advancement, investment in human capital and investment attractiveness. Countries with dominant high-value-added sectors and a strong presence of multinational corporations generate significantly higher turnover per worker compared to countries whose economies are based on labour-intensive and low-value-added sectors. More developed countries, led by the technology and financial sectors, are able to generate significantly higher value added per worker. In contrast, countries with a lower level of development, dominated by traditional and lower productivity sectors, have a limited capacity to achieve high values for this indicator. In order to improve performance, Romania and Bulgaria, Latvia and Greece need to increase investment in innovation and infrastructure development to gradually improve labour efficiency and increase the value added generated per worker.

In countries such as Poland and Slovakia, wages are relatively lower compared to Western European countries, which means that the share of labour costs in total production costs remains relatively low. In Poland and Slovakia, foreign companies play a significant role in the economy as thry relocate production to these countries in order to reduce costs. Low labour costs, combined with relatively high productivity, mean that the share of labour costs in production costs remains low. These differences also reflect broader economic trends in Europe, with Eastern European countries being more cost-competitive and Western European countries investing in human capital and raising labour standards, but with higher labour costs.

As a result of the pandemic, many companies reduced the scope of their operations or suspended them altogether, which resulted in lower demand for employees. Weaker economic performance and uncertainty about the future led companies to cut back on staff to reduce operating costs. The shift to remote working in some sectors has meant less need for traditional office jobs, and some companies have opted to downsize by introducing automation and digitisation of business processes.

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THE PURCHASING PATTERNS THAT HAVE PERMANENTLY BECOME ESTABLISHED AMONG POLISH RESPONDENTS BECAUSE OF THE COVID-19 PANDEMIC

Kateryna LYSENKO-RYBA[1], Marharyta REVENIUK[2*]

[1] University of Information Technology and Management, Rzeszow; klysenko@wsiz.edu.pl, ORCID: 0000-0003-1560-1063
[2] University of Information Technology and Management, Rzeszow; mreveniuk@wsiz.edu.pl, ORCID: 0009-0002-7124-2704
* Correspondence author

Purpose: The present study investigates the impact of COVID-19 on Consumers' behaviour during the purchasing. The aim is to investigate changes in customer purchasing behavior that may have occurred during the Covid-19 pandemic. The additional goal was to find out whether the behavior forced by restrictions turned into a habit after the pandemic.
Design/methodology/approach: A questionnaire survey was carried out in 2023 to understand the impact of COVID-19 on consumers' attitude towards purchasing. The research was purposely conducted 2 years after the pandemic in order to examine the purchasing patterns that have permanently become established among respondents. The study sample mainly focused on students from Poland, with data gathered using an online survey method. The chi-square test was used to determine the representativeness of the sample file.
Findings: According to survey results, people up to the age of 18 were much less likely to make purchased goods returns (19.0%), while people over 60 years (50.0%) make returns more often than in the pre-pandemic period. The respondents over the age of 60 (50.0%) also paid more attention to whether the company is pro-ecological than it was for people under 18 (14.3%). Among statistically significant behaviors, it can be indicated that women prefer online shopping more than before the pandemic (50.3%), men showed this less often (36.0%), and female pay much more with non-cash payments than before the pandemic - 44.8%, male only 26.7%. According to the research, students/ disciples (13%) are more willing to shop stationary than before the pandemic, but such dependence was not noticed among working people (3.6%).
Research limitations/implications: The study results have several findings and implications primarily for practitioners, policymakers and managers. Retailers can use this information to change their sales strategies and sales processes. Moreover, they can enhance customer interactions to better meet and exceed their expectations. The presented research results are necessary to better understand customer behaviors that have changed during the Covid-19 pandemic and have consolidated in the post-pandemic period. The presented findings enrich the theoretical understanding of customer behavior and customer purchase intentions. They also provide retailers with a quantitative point of view and a new perspective on designing modern, more tailored sales processes to improve customer satisfaction.

Practical implications: As with other studies of this type, the results and implications are limited due to the research design and methods used. However, these limitations also indicate potential directions for future research. Conducting scientific research is associated with many challenges in the area of behavior change. The topic is current, multidisciplinary, characterized by unusual dynamics, which requires different points of view. Perhaps a similar study should have been conducted on a wider research sample, conducting interviews with respondents from different countries (e.g. Visegrad Group), analyzing the behavior of different clients with different mentality and in different life situations, as well as age.
Originality/value: The article explores the lasting impact of COVID-19 on consumer shopping behavior and preferences from a new angle, considering demographic changes in consumer habits following the pandemic.
Key words: customer purchasing behavior, purchasing patterns, COVID-19.
Category of the paper: Research paper.

1. Introduction

According to Das et al. (2022) such aspects as environmental, social, biological, cognitive, and behavioral aspects have significant impact for changes in consumer behavior around their needs and preferences. Consumers behavior is influenced by their internal needs and motivations, but also by the external environment in which they operate (Rajagopal, 2019). Various factors in the environment in which the entity operates may have a greater or lesser impact on its behavior. Analysis of historical events shows us that pandemics and epidemics consistently and significantly affect human life from year to year (e.g. Ebola outbreak). Pandemics like Covid-19 can contribute to changes in consumption behavior, disrupting current stability and moreover prompting customers to plan their spendings more carefully because of the occurrence unexpected issues such as price increases or shortages of certain items. These changes may be long-term and continue also after the pandemic. The outbreak of the COVID-19 pandemic probably has affected every possible aspect of human life.

Due to the lockdown, areas such as people's health and financial well-being, safety, social connections significantly have been affected. Paradoxically, this has suffered despite numerous efforts to contain the pandemic. It also forced most consumers to change their current behavior, both during the purchase process and after purchasing, when returning these goods to the seller. Cariappa et al. (2020) reported that 92.01% of respondents declared that they noticed changes in their purchasing behavior. An estimated 90% of respondents linked this change to the risk of infection and strict isolation. According to (Eger et al., 2021), consumer purchasing behavior during the COVID-19 pandemic was primarily driven by fear. The greater the fear, the greater the change in purchasing behavior. The most common fear was fear of infection, complications, and death (Chalhoub et al., 2022).

As the research results show (Veselovská et al., 2023), it can be stated that the COVID-19 pandemic has changed people's thinking about such different areas of life, especially about such common things as choosing a place to shop, choosing a supplier or saving. The pandemic has changed thinking in an irreversible way. Pursued Ease of Use (PEU) and Perceived Usefulness (PU), product price and trust had significant impact on online consumer purchasing behavior during the Covid-19 pandemic among young adults (Yee et al., 2023). Consumer behavior has changed during the pandemic due to fear-driven impulse buying, increased awareness of local products, the need to reduce waste, and sustainable consumption (Kongming, 2023). Purchasing patterns have changed and become more value-oriented after the pandemic (Mbongwe, Qutieshat, 2023). Quantitative changes in purchased goods were also recorded: consumers began to focus on more economical packaging, purchasing larger capacities. Attention was also drawn to the need to stay at home and limiting mass visits to markets, resulting in high purchasing activity uploaded to various online platforms and delivery services. Such changes, of course required switching to cashless payment methods, which was not common before practice (Huterska et al., 2021). After Covid-19 pandemic consumers prioritizing essentials over comfort and luxury items, consumers have adopted restrictive living conditions and are more concerned about their spending and buying patterns (Pang, Ko, Kim, Ko, 2022). Before the Covid-19 pandemic, 67% of consumers said brands needed to do more to guide their purchasing decisions online and preferred to visit a physical store to consider their purchase decision (Zoovu, 2020). After the pandemic, 74% of consumers are interested in a solution that independently recognizes their needs in real time based on their responses and issues a personalized recommendation. These results show that consumers have become more resourceful, independent, and open to technology. The COVID-19 pandemic has led to an increase in online shopping, primarily due to government-imposed restrictions. Consumers' personal concerns about their own health related to shopping in physical stores were also an important factor (Shaw, Eschenbrenner, Baier, 2022). The global increase in e-commerce due to the Covid-19 pandemic was initially driven by the need to avoid person-to-person contact. The outbreak of the COVID-19 pandemic and the introduced lockdown necessitated an immediate response by companies, both in response to the restrictions introduced, as well as changes in the assumptions and strategies that guided sellers in the long term. Some of them had to create an online store or seriously revive it. Online shopping was the only alternative as retail stores were closed and people stayed at home to avoid spreading the virus. Faced with various barriers and restrictions hindering visits to stores, many consumers decided to shop online. This shift in shopping caused global e-commerce to rose from 15% of total retail sales in 2019 to 21% in 2021. It now sits at an estimated 22% of sales (Morgan Stanley's report, 2022). Optoro, a leading returns technology provider that provides services to manage, process and resell returned goods, saw a 20% decline in average weekly returns at the end of the pandemic (Optoro, 2021). Similarly, Returnly, a digital returns platform supporting retail chains, saw e-commerce returns decline by 21% after the government-recommended lockdown

(Returnly, 2021). During the Covid-19 pandemic, in order to build consumers' trust and encourage them to buy despite higher uncertainty and risk, companies have started to adopt more liberal returns policies, which in turn can lead to higher returns than in traditional retail.

While researchers have examined the various areas of social and economic life in which changes in consumer behavior have been noticed during and after the Covid-19 pandemic, we still do not know enough about **the changes in behavior of Polish consumers that may have occurred during the Covid-19 pandemic and adapted to their habits.** Taking into account the theoretical gap in the literature on the subject, the article explores and analyzes the changes in purchasing behavior of customers after the Covid-19 lockdown.

First, we tried to explore how the Covid-19 pandemic changed consumer behavior and which behaviors stayed with consumers 2 years after the pandemic. Then, we tried investigated socio demographic features that have impact on purchasing behavior. In order to realize the goal, it is necessary to answer 3 research questions:

RQ1: How the Covid-19 pandemic changed consumer behavior?

RQ2: Does age influence differences in respondents' purchasing behavior?

RQ3: Which gender prefers more online shopping?

Answering this question not only fills an academic gap but also provides various insights for the changes in purchasing behavior of customers after the Covid-19 lockdown that have the greatest impact on becoming rooted in habits. It can be concluded that these changes influenced the comfort, safety and greater awareness of the respondents.

2. Literature review

2.1. Factors determining online shopping

At the end of 2021, when the pandemic began to slow down, some governments began to ease their restrictions and consumers began to return to shopping in stationary stores, which created a risk that the number of online purchases would decline after the reopening of stores. However, there were concerns that consumers may still prefer online shopping more often than before the pandemic due to the experiences gained during isolation. Researchers note that convenience, efficiency and security play an important role in women's perceptions about online shopping, which influences their desire to continue shopping online (Sehkal et al., 2021). To increase e-commerce sales, sellers must create a positive experience for customers by paying attention to aspects such as website design, reliability and quality of after-sales support (Holloway, Beatty, 2003). Customer satisfaction after completing a transaction is a key factor for subsequent returns and store recommendations (Camilleri, 2021; Zhang et al., 2013).

When buying physical goods online, one of the elements that determine the overall quality of service is the fulfillment of the order, which can be assessed by delivery times, the correctness of the order contents and delivery standards. One of the unique features of stationary retailers, highly appreciated by consumers, is the ability to have direct contact with the products they want to buy and with the staff in the store. The key difference between online and offline shopping is real interaction between people and personalized shopping experiences. For example, many customers like to talk to a sales representative to get advice and talk about different products in a natural conversational style. When shopping in-store, customers can choose the item they want and take it home to use right away, without needing expert advice to see how valuable the item is. However, there are sectors in which online sales have a greater impact, such as when buying digital products such as e-books and software, as the goods are instantly delivered after payment (Rao et al., 2011). In contrast, when purchasing physical goods online, there is a delay due to the need for delivery. Customers may also face additional shipping costs, which can be significant. Given the potential delays, inconvenience with returns, and the risk of receiving the wrong product, some consumers may avoid online shopping (Titiyal et al., 2022).

Despite the so-called "post-COVID" era, the trade situation is changing rapidly. Retail and e-commerce companies have noticed new changes in shopping behavior, and the changes that have occurred over the past year are showing signs of adoption in habits. First thing is contactless payment. According to BigCommerce (2022) it may not be correct to expect online transactions to replace every purchase made in person. The use of contactless mobile payments has increased significantly during the pandemic, with growth of 22.2% in 2020 according to eMarketer (eMarketer, 2021). There is also an important trend towards browsing and buying products directly on social platforms, which has become a key aspect of e-commerce. Consumers browse products and complete transactions via social media and content creation platforms, all using a dedicated app. This new form of shopping removes friction from the purchasing process, provides a more immersive consumer journey and provides brands with new opportunities to capture consumer interest (McKinsey & Company, 2022). In 2020, social commerce accounted for 3.4% of total e-commerce sales and is expected to increase further. In addition, many millennials and members of Generation Z believe that social media is the optimal platform for sourcing new products, as opposed to traditional online search (BigCommerce, 2022).

Another strong phenomenon in e-commerce is paying even more attention to the management of returns, which on the one hand generate large logistics costs (Shang et al., 2017) and on the other hand contribute to increasing customer loyalty. The basis for long-term loyalty of buyers is their positive attitude to the offer, an indispensable element of which is the pro-consumer returns and complaints policy. The issue of returns is very important (Frei et al., 2002). It gives the customer security and guarantees that the seller is sure of the products offered by him and is ready to take responsibility for them (Barlow, Maul, 2000). A conscious and more

demanding customer has higher expectations of his rights when processing returns. Consumers returned a staggering $817 billion worth of products, representing just over 16% of total retail sales in US Statista (2023). The National Retail Federation estimates the cost of returns to be $101 billion. Return rates for all retail purchases can be as high as 10%, and for e-commerce, return rates can go up to 30% (NRF, 2021). Companies offer their clients return policy in order to reduce the post-purchase risk. The increased number of online purchases, especially during the Covid-19 pandemic, has another strong phenomenon in e-commerce is paying even more attention to the management of returns, which on the one hand generate large logistics costs (Shang et. al.2017) and on the other hand contribute to increasing customer loyalty. The basis for long-term loyalty of buyers is their positive attitude to the offer, an indispensable element of which is the pro-consumer returns and complaints policy. The issue of returns is very important (Frei et al., 2002). It gives the customer security and guarantees that the seller is sure of the products offered by him and is ready to take responsibility for them (Barlow, Maul, 2000). A conscious and more demanding customer has higher expectations of his rights when processing returns. Consumers returned a staggering $817 billion worth of products, representing just over 16% of total retail sales in US (Statista, 2023). The National Retail Federation estimates the cost of returns to be $101 billion. Return rates for all retail purchases can be as high as 10%, and for e-commerce, return rates can go up to 30% (NRF, 2021). Companies offer their clients return policy in order to reduce the post-purchase risk. The increased number of online purchases, especially during the Covid-19 pandemic, has made customers pay more attention to the delivery time of the ordered goods and the possibility of returning an incorrect purchase easily and free of charge. A company that had a more efficient customer support system based on well-organized and fast reverse logistics processes had a chance to attract a larger pool of loyal customers. When seller that does not accept returns or allows the exchange of goods:

- he completely ignores of the principles of customer service,
- he is not sure about the quality of goods or services provided,
- he did not include the returns policy in the company's logistics system, which makes him unable to manage these returns.

Nowadays, e-commerce cannot take place without the return of unwanted or disliked goods by customers. Returns and complaints are an integral part of contemporary business. Guaranteeing of a friendly return policy (“no questions asked” policy, hassle free return policy) by the company and, what is more, its effective and efficient implementation more often become an element of competitive advantage. During the Covid-19 pandemic, in order to build trust and encourage consumers to buy despite higher uncertainty and risk, companies have started to adopt more liberal returns policies, which in turn can lead to higher returns than in traditional retail. However, the research results show otherwise. Optoro, a leading returns technology provider that provides services to manage, process and resell returned goods, saw a 20% decline in average weekly returns at the end of the pandemic. Similarly, Returnly,

a digital returns platform supporting retail chains, saw e-commerce returns decline by 21% after the government-recommended lockdown (Returnly, Optoro, 2021). We can observe very similar statistics in Europe, and especially in Poland.

2.2. Changes in shopping behavior in Poland during and after Covid-19

In the period January-March 2020, due to the coronavirus pandemic and the closure of many stationary stores in Poland, the number of e-commerce stores increased compared to the same period in 2019. Since April 2020, the Polish economy has been undergoing rapid changes caused by the Covid-19 pandemic. Restrictions on traditional trade affected GDP, which was 2.8% lower than in 2019 (Markethub.pl, 2021). In 2020, most online stores were created in the categories of books and media, food products, gifts and accessories (Statista 2024). In 2023, the Polish Allegro market achieved revenues of over PLN 10.2 billion, which means an increase of 14%. compared to the same period last year. Allegro also owns the Ceneo.pl pricing website. Ceneo's revenues increased by 7% in the observed period, reaching nearly PLN 208 million in 2023 (Statista, 2024).

The coronavirus has gradually changed the behavior of Polish consumers, who switched from offline to online sales, change payment methods, pay less in cash, and more recently use their credit cards and phones (NBP, 2022). When it comes to the method of goods delivery, Polish consumers became more interested in parcel lockers, which during the pandemic offered contactless parcel collection using a mobile phone.

According to Business Insider Polska, during 2020, the percentage of returns on the Allegro platform among Polish consumers mostly did not change and remained at a very low level. Moreover, in March 2020, compared to February 2020, this percentage decreased and the average number of returns in the first quarter of 2020 was approximately 40%. lower than in the fourth quarter of 2019 (Business Insider, 2020). These declines are likely due to consumer caution and adherence to government rules. Consumers wanted to minimize the additional stress of leaving home to go to the store during the pandemic to return purchases. According to the report of the postal operator PostNord "E-commerce in Europe 2020", the percentage of online consumers in Poland reached 83% in 2020, in 2019 it was 80%. The dynamics of online trade was boosted by the restriction of sales on Sundays and by restrictions because of lockdown. In Poland, the Allegro marketplace has withstood the pressure from foreign e-commerce giants and holds a dominant position in the market. 38% polish consumers prefer “Collect it by myself from a parcel machine”, 35% - “Home delivery in daytime” (PostNord, 2020).

The Covid-19 pandemic has had a visible impact on the collection of parcels and the processing of returns by customers. The PBS report shows that collecting parcels from a courier is still the dominant trend - 73% of respondents, however, collecting parcels at a parcel locker was chosen by almost 43% of respondents (PBS, 2021). Without a doubt, the main role in this

case was the sense of security associated with the ability to maintain social distance. During the pandemic, leading logistics operators and courier companies, wanting to adapt to the new reality, introduced many changes and improvements aimed at increasing safety also when collecting a parcel at the door directly from the courier. Such improvements include:

- cashless payment with the courier - sanitary issues forced companies to introduce portable terminals for this purpose,
- development of a network of parcel lockers that allow you to collect parcels at any time, 24 hours a day, and contactless door opening using a smartphone has largely contributed to increasing consumer safety,
- contactless confirmation of receipt by adding special, one-time PIN codes that were universally assigned to each shipment,
- introduction of disinfection procedures - wearing gloves by couriers, disinfection of parcels (spraying them in the warehouse), cleaning and disinfection of cars transporting parcels, constant sanitary supervision of company employees.

Following an analysis of the literature, it can be concluded that the timeliness of this article is justified by the lack of research into changes in the behaviour of strictly Polish consumers. Although researchers (Cariappa et al.; Barlow et al.; Yee et al.) have investigated various aspects of social and economic life where shifts in consumer behavior have been observed during and after the Covid-19 pandemic, there remains a lack of comprehensive understanding regarding changes in the behavior of Polish consumers during this period and how these changes may have influenced their habits. Addressing this theoretical gap in the literature, this article examines and analyzes the transformations in purchasing behavior among customers following the Covid-19 lockdown.

3. Research Methodology

In addition to the literature review, research surveys were conducted using the computer-assisted website interview (CAWI) technique. The online survey questionnaires were distributed using the servers of the Google. The purpose of the research was to investigate changes in customer behavior especially in terms of product return, that may have occurred during the Covid-19 pandemic. The most interesting thing was to find out whether the behavior forced by restrictions turned into a habit after the pandemic. The following gender and age amounts were used in the study:

- 51% of male and 49% of female,
- 68,9% of people aged 18 to 26.

The research process related to the collection of primary data consisted of two stages: pilot and proper studies. In each of them, questionnaire surveys were used to collect primary data. The actual survey was carried out among 305 people representing Polish adult final buyers, mostly students. The research was purposely conducted 2 years after the pandemic in order to examine the purchasing patterns that have permanently become established among respondents. The actual survey was carried out in April and May 2023. According to the Central Statistical Office, 37,637 million people lived in Poland at the time of the research.

Table 1.
Demographic structure of the study sample [n = 305]

Sociodemographic characteristics	**n**	**%**
Age		
up to 18 years old	21	6,9%
from 18 to 26 years old	210	68,9%
from 27 to 45 years old	44	14,4%
from 46 to 60 years old	9	2,6%
over 60 years old	22	7,2%
Sex		
female	149	49,0%
male	156	51,0%
Place of residence		
village	104	34,1%
city up to 20 000	28	9,2%
city from 20 000 up to 150 000	59	19,3%
city from 150 000 up to 500 0000	85	27,9%
city over 500 000	29	9,2%
Education		
primary	9	3,0%
vocational	6	2,0%
technical secondary	96	31,5%
general secondary education	108	35,4%
higher	86	28,2%
Type of professional activity		
unemployed	2	0,7%
have own business	9	3,0%
employed in a company / institution	88	28,6%
pensioner	14	4,7%
student	186	61,0%
disciple	6	2,0%
Average net income per month		
no income	72	23,6%
up to PLN 4000	107	35,1%
4001-6000 PLN	82	26,9%
6001-8000 PLN	24	7,5%
8001-10 000 PLN	12	4,3%
over 10 000 PLN	8	2,6%

Source: created by the authors.

The research procedure consisted of the following stages:

1. Selecting a research sample.
2. Constructing a prototype of a survey on changes in consumer behavior in terms of returns during a pandemic and verifying the survey in a pilot group.

3. Analysis of results, making corrections in survey questions.
4. Conducting research on a verified and tested questionnaire, hosted on the servers of the Google.
5. Analyzing and discussing the results obtained from the study.
6. Drawing conclusions based on analysis and discussion, limitations and future research directions.

4. Analysis of the obtained research results

In the following part of the study, the results of the study will be presented in relation to the impact of the Covid-19 pandemic on consumer behavior relative to their social personality. Figure 1 shows the results of how the pandemic has contributed to changes in consumer purchasing behavior. **It can be clearly stated that the majority of respondents noticed changes in their behavior in relation to the increase in online purchases (42%),** what could have been caused by restrictions introduced by the Government in terms of movement and restrictions on stationary sales. Developed habits for online shopping in a few years, have been preserved in the minds of consumers as an easier and more accessible way to make purchases. In addition, the trend towards non-cash payments noticeable during the pandemic contributed to the remaining settlement method in as many as 35.6% of respondents. **However, 40.3% of respondents did not change their shopping behavior, which may involve the active use of online shopping in the period before the pandemic** and the same degree of stationary purchases in the field of goods available immediately.

A small percentage of respondents noticed changes in the increase in the frequency of returns (7.5%) or preference for stationary purchases online (9.5%). Such a phenomenon may indicate that consumers are guided by their own preferences in order to satisfy their own needs. A small percentage of respondents began to pay attention to the pro-ecological activities of the company (5.6%), which may have been caused by changes in EU regulations in the field of sustainable policy.

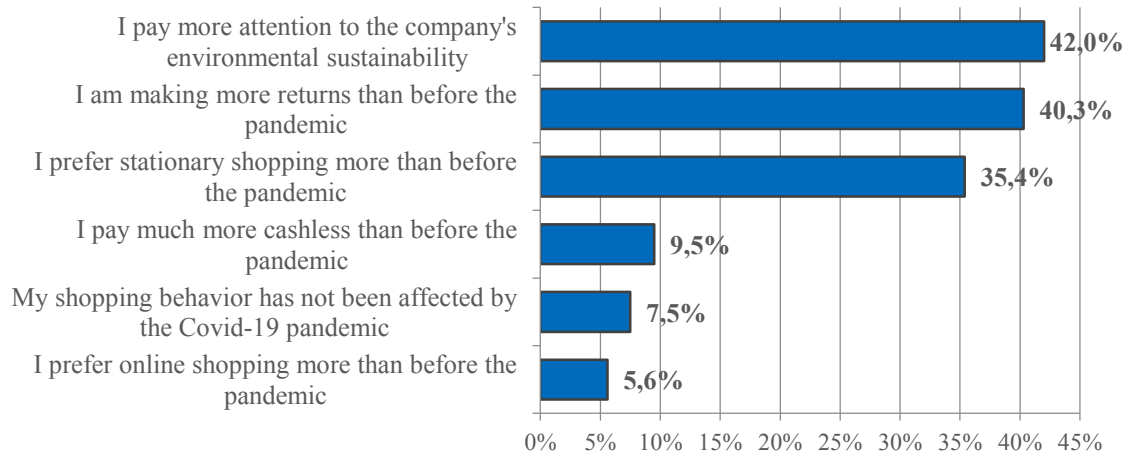

Figure 1. The evaluation of how the Covid-19 pandemic affected the respondents' shopping behavior (The answers given in the multiple choice question do not equal 100%, n = 305).

Source: created by the authors.

Moreover, it can be stated that the restrictions related to the Covid-19 pandemic in most cases (59,7%) had an impact on consumer behavior also after the pandemic, which was subject to a broader analysis later in the study (Figure 2).

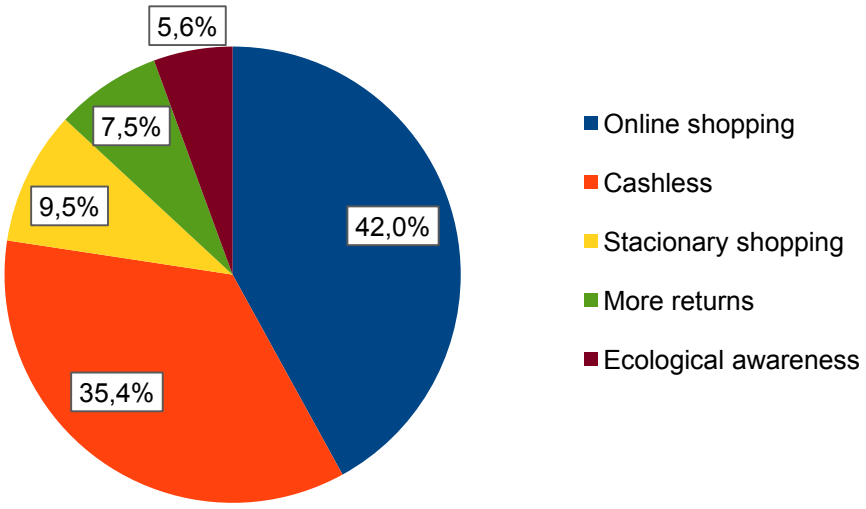

Figure 2. Changes in consumer behavior during the pandemic, which have become embedded in their lifestyle.

Source: created by the authors.

The results of chi-square tests in 2 cases showed a statistically significant relationship ($p < 0.05$) between the cases in which the Covid-19 pandemic changed the shopping behavior of respondents and their age (tab. 1). **Subjects over the age of 60 (50.0%) were the most numerous group that made returns more often than by the pandemic, while people up to the age of 18 were much less likely to make such returns (19.0%). The respondents over the age of 60 (50.0%) also paid more attention to whether the company is pro-ecological than it was for people under 18 (14.3%).**

Table 2.
An assessment of how the Covid-19 pandemic changed the purchasing behavior and age of respondents [The answers given in the multiple choice question do not equal 100%, n = 305]

Factors:	**up to the age of 18 [n=21]**	**18 to 26 years old [n=210]**	**27 to 45 years old [n=64]**	**46 to 60 years old [n=8]**	**over the age of 60 [n=2]**	**Statistical significance**
I prefer online shopping more than before the pandemic	28,6%	41,0%	48,4%	50,0%	50,0%	$\chi2$=3,00116 p=0,55763
I prefer stationary shopping more than before the pandemic	23,8%	10,5%	3,1%	0,0%	0,0%	$\chi2$=9,30204 p=0,05397
I am making more returns than before the pandemic	19,0%	5,7%	9,4%	0,0%	50,0%	**$\chi2$=11,12531 p=0,02519**
I pay more attention to the company's environmental sustainability	14,3%	5,2%	3,1%	0,0%	50,0%	**$\chi2$=11,77482 p=0,01910**
I pay much more cashless than before the pandemic	28,6%	35,7%	35,9%	50,0%	0,0%	$\chi2$=2,28672 p=0,68318
My shopping behavior has not been affected by the Covid-19 pandemic	52,4%	41,0%	34,4%	37,5%	50,0%	$\chi2$=2,34857 p=0,67193

$\chi2$ – chi-square test result; p – statistical significance; * - p < 0,05

Source: created by the authors.

Such behavior may indicate that the older generation does not think about the negative impact of their behavior on the environment, but they pay attention to the activities of companies in a pro-ecological way. This may be due to the prevailing claim that the company must act pro-ecologically, and the consumer paying the company for services covers the cost of damage that can be caused by actions aimed at satisfying the customer. The generation of young people, on the other hand, does not translate responsibility into companies, makes more thoughtful purchases and therefore makes a much smaller percentage of returns.

The results of chi-square tests ($p < 0.05$) in three cases showed a statistically significant relationship between the impact of the Covid-19 pandemic on the purchasing behavior of respondents compared to their gender. **Among statistically significant behaviors, it can be indicated that women prefer online shopping more than before the pandemic (50.3%), men only (36.0%), and they pay much more with non-cash payments than before the pandemic (44.8%), men only (26.7%).**

Table 3.
The impact of the Covid-19 pandemic on the purchasing behavior of respondents compared with their gender [The answers given in the multiple choice question do not equal 100%, n = 293]

Factors:	female [n=143]	male [n=150]	Statistical significance
I prefer online shopping more than before the pandemic	50,3%	36,0%	**χ2=6,15021 p=0,01313**
I prefer stationary shopping more than before the pandemic	9,1%	10,0%	χ2=0,07000 p=0,79133
I am making more returns than before the pandemic	7,7%	6,7%	χ2=0,11574 p=0,73369
I pay more attention to the company's environmental sustainability	7,7%	3,3%	χ2=2,69441 p=0,10070
I pay much more cashless than before the pandemic	44,8%	26,7%	**χ2=10,46185 p=0,00121**
My shopping behavior has not been affected by the Covid-19 pandemic	30,8%	48,0%	**χ2=9,08809 p=0,00257**
χ2 – chi-square test result; p – statistical significance; * - p < 0,05			

Source: created by the authors.

This difference can be caused by the fact that women are more likely to make purchases than men. The ability to order various goods without spending time in the store has contributed to the development of the e-commerce industry.

The results of the chi-square tests ($p < 0.05$) presented in Table 3 showed one example of a statistically significant relationship between the impact of the Covid-19 pandemic on the shopping behavior of respondents and the type of their professional activity. **According to the research, students/disciple (13%) are more willing to shop stationary than before the pandemic, but such dependence was not noticed among working people (3.6%).**

Table 4.
The impact of the Covid-19 pandemic on shopping behavior and the type of professional activity of respondents [n = 302]
[The answers given in the multiple choice question do not equal 100%, n = 293]

Factors:	Student/disciple [n=192]	Working person [n=110]	Statistical significance
I prefer online shopping more than before the pandemic	38,5%	48,2%	χ2 2,66702 p=0,10244
I prefer stationary shopping more than before the pandemic	13,0%	3,6%	**χ2=7,09511 p=0,00772**
I am making more returns than before the pandemic	7,8%	7,3%	χ2=0,02895 p=0,86487
I pay more attention to the company's environmental sustainability	7,3%	2,7%	χ2=2,74266 p=0,09770

Cont. table 4.

I pay much more cashless than before the pandemic	33,9%	38,2%	$\chi2$=0,57251 p=0,44926
My shopping behavior has not been affected by the Covid-19 pandemic	42,2%	36,4%	$\chi2$=0,98777 p=0,32028
$\chi2$ – chi-square test result; p – statistical significance; * - p < 0,05			

Source: created by the authors

Such dependence may be due to the fact that students/ disciple are more aware of the importance of protecting the environment and taking care of it along with reducing harmful emissions, thus, when choosing stationary purchases, they contribute to the reduction of carbon dioxide (CO2).

5. Discussions and conclusion

There is no doubt that the Covid-19 pandemic has had a significant impact on the way people behave, think and shop. Many experts believe that the surge in online shopping will continue the positive trend. As more people become accustomed to the convenience of shopping at home, it is likely that e-commerce will continue to grow and evolve into new and more convenient forms for consumers in the coming years. The Covid-19 pandemic has had long-term effects on global trade, and the increase in online shopping is just one of many changes. As we progress and develop, it is important to understand the impact of the Covid-19 pandemic on the exponential growth of online shopping and the likely evolution of e-commerce in a post-pandemic world (Szasz et al., 2022).

In our study, we've formulated three research questions. Thanks to the precise answers of the respondents, accurate answers were obtained:

- **RQ1: How the Covid-19 pandemic changed consumer behavior?** The pandemic has contributed to changes in consumer purchasing behavior. It can be clearly stated that the majority of respondents noticed changes in their behavior. 42% of respondents admitted to changing their shopping habits towards online shopping, 35.6% of respondents are switching towards cashless payments, which contributed to leaving the traditional method of settlements. A small percentage of respondents noticed changes in the increase in the frequency of returns (7.5%) or preference for stationary purchases online (9.5%). However, 40.3% of respondents did not change their shopping behavior, which may involve the active use of online shopping in the period before the pandemic and the same degree of stationary purchases in the field of goods available immediately.

- **RQ2: Does age influence differences in respondents' purchasing behavior?** Yes, age differentiates respondents' purchasing behavior:
  - People up to the age of 18 were much less likely to make such returns (19.0%), while people over 60 years of age (50.0%) make returns more often than in the pre-pandemic period. Pre-pandemic research by Source et al. (2005) suggests that age affects online shopping behavior and product returns, especially if the consumer searched for the product online (Sorce et al., 2005). The results of this research show that the percentage of purchases by age category is very similar. Comparing this result to the study described in the article (the younger generation makes fewer returns), we can see a difference indicating an increase in the number of returns over time. Comparing our study to the Basak et al. (2022) survey, according to which the online shopping return rate among young Indian consumers is close to 50%, there is a noticeable difference in consumer awareness about return policy. Such a difference is due to a much more reduced risk in the return policy of online stores in India. The return policy in Poland is friendly to consumers, but in parallel with this, companies are introducing changes to make the return policy more environmentally friendly.
  - The respondents over the age of 60 (50.0%) also paid more attention to whether the company is pro-ecological than it was for people under 18 (14.3%). According to our research, students/disciples (13%) are more willing to shop stationary than before the pandemic, but such dependence was not noticed among working people (3.6%). Our research shows that students/students are more likely to shop stationary than before the pandemic, but among other studies, this data is not confirmed. The pandemic has accelerated the development of e-commerce and consumers spend more time on online shopping platforms (Ingaldi, Brožová, 2020; Akçagün et al., 2021; Ludin et al., 2022). International students, especially those from Asia, have shown a greater change in buying habits, including increased online shopping and preferences for local products (Szlachciuk et al., 2022). This trend is attributed to factors such as convenience, pandemic restrictions and the adaptation of brick-and-mortar stores to online platforms (Ludin et al., 2022). These results suggest a significant transformation of consumer behaviour, especially among students, as a result of the COVID-19 pandemic.
- **RQ3: Which gender prefers more online shopping?** Among statistically significant behaviors, it can be indicated that women prefer online shopping more than before the pandemic (50.3%), men only (36.0%), and they pay much more with non-cash payments than before the pandemic (44.8%), men only (26.7%). Many studies from different countries show us that female consumers were more likely to shop online during the Covid-19 pandemic than before the pandemic, paying particular attention to cashless payment (Kráľ et al., 2022; Ohata et al., 2022; Singh et al., 2022). As we can see from

the results of that research, the trend continues. Post-covid behavior related to the convenience of online shopping and the favorable factors for non-cash payments and a consumer-safe return policy, which began to grow during the pandemic became established in the consumer behavior of both sex groups.

International events, such as the economic, geopolitical or biological crisis, introduce many changes in consumer behavior. Until recently, we have been dealing with the global crisis of the Covid-19 pandemic, and today we are facing a political crisis. Such phenomena clearly indicate not only changes in the market, but also changes in consumer expectations and behavior. In this article, the authors presented the results of an online survey among Polish consumers conducted in April-May (N = 305). The authors also compared consumer behavior before, during and two years after the outbreak of the pandemic. The results have led to some conclusions: the age and gender of consumers have a direct impact on the way purchases are made and their returns. Younger people shop more responsibly and have less negative impact on the environment than the way older people shop.

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MIGRATION DRIVEN BY CRISES IN THE CONTEXT OF SUSTAINABLE REGIONAL DEVELOPMENT

Katarzyna ŁUKANISZYN-DOMASZEWSKA[1], Katarzyna MAZUR-WŁODARCZYK[2*]

[1] Opole University of Technology, Faculty of Economics and Management;
k.lukaniszyn-domaszewska@po.edu.pl, ORCID: 0000-0002-2165-5095
[2] Opole University of Technology, Faculty of Economics and Management; k.mazur-wlodarczyk@po.edu.pl,
ORCID: 0000-0002-4822-9328
* Correspondence author

Purpose: This article examines the evolving trends and key research areas in crisis migration, refugee movements, and sustainable development, with the goal of identifying recent challenges, emerging themes, and future directions. It aims to bridge the gap between academic insights and practical policymaking by highlighting the dynamic relationship between migration issues and sustainable practices.
Design/methodology/approach: A systematic review of publications indexed in the Web of Science (WoS) and Scopus databases was undertaken to analyze trends, identify leading contributors, and highlight emerging research themes. The analysis focuses on publication outputs, citation patterns, and thematic shifts influenced by global crises, particularly the Covid-19 pandemic.
Findings: The study reveals a substantial growth in research output on crisis migration, reflecting the increasing global relevance of this topic. Russia, Germany, and the UK are identified as leading contributors, with the US producing the most widely cited works. Recent literature demonstrates an expanding focus on pandemic-related challenges, with terms such as "Covid", "pandemic", and "health" prominently featured. Central themes include the experiences of Syrian refugees, Afghan migrants, and women, alongside growing attention to regional issues in Germany, Russia, Poland, and the role of asylum seekers. These findings illustrate the multidimensional nature of crisis migration and underscore its intersection with sustainable development goals.
Originality/value: This study provides a detailed analysis of the current state of crisis migration research, emphasizing its response to contemporary global challenges, such as health crises and forced displacement. The findings offer a roadmap for future academic inquiry while delivering actionable insights for policymakers aiming to incorporate sustainable development principles into migration responses. By addressing both established and emerging themes, this article contributes to a more nuanced understanding of migration dynamics in a rapidly changing world.
Keywords: crisis migration, refugee migration, migration challenges, sustainable development.
Category of the paper: Literature review.

1. Introduction

Crisis migration, particularly when driven by conflict, persecution, or environmental catastrophes, has become one of the most pressing challenges in the field of migration studies and sustainable development (Black, 2018; Estevens, 2018; Hugo, 2008; Raleigh, 2011). As populations are displaced due to war, natural disasters, or political instability, the impact on both host and origin regions is profound, affecting social, economic, and environmental sustainability. Given the magnitude and complexity of migration in crisis situations, it is essential to understand the dynamics at play in order to design policies that can both manage migration flows and contribute to long-term sustainable development. This is particularly important as migration is not just a result of crisis events but also an important factor in shaping regional and global development trajectories (Black, 2018).

This study provides an overview of the literature on crisis migration, refugee movements, and sustainable regional development. Using a systematic review approach, it evaluates recent trends, key subject areas, and the most commonly used terms in research publications from Web of Science (WoS) and Scopus databases. The focus of this paper is to address research questions related to current research trends, subject areas, and keywords in crisis migration and sustainable development, as well as to explore recent issues, challenges, and emerging future trends in this field. This paper seeks to answer important questions regarding the relationship between migration and sustainable development, the factors influencing the displacement of populations, and the ways in which these phenomena are studied and understood in contemporary scholarship.

The primary aim of this study is to map out the growing body of literature on crisis migration, refugee migration, and sustainable development by examining the period from 1989 to 2022, utilizing data from the WoS and Scopus databases. In doing so, this study identifies the key research topics and geographical regions that have been central to the discussion in recent decades. The focus on crisis migration and refugee flows has intensified, particularly in the aftermath of significant global events, such as the Syrian civil war, the COVID-19 pandemic, and the ongoing Russia-Ukraine conflict. Furthermore, this paper highlights the shifting terminology used in the literature, such as the introduction of terms like "pandemic", "Brexit", and "Syrian refugee", in response to these events, while also noting the lack of attention to more recent crises, such as the displacement resulting from the 2022 war in Ukraine.

This systematic review aimed to evaluate the key trends in academic literature on these interconnected topics and to identify gaps in the research, especially concerning the underrepresentation of certain refugee groups in mainstream studies. The study highlights that while research interest in crisis migration and sustainable development has surged, the literature on some of the most current refugee crises, such as the Ukrainian migration crisis, is still underdeveloped, potentially due to delays in publication and indexing in major academic

databases. The COVID-19 pandemic has reshaped the scope of migration research, introducing new dimensions such as health crises, border management, and migration governance.

Several scholars have addressed the complex relationship between migration and sustainable development. Castles (2010) and Martin (2022) discussed migration as both a cause and a consequence of sustainability challenges, noting its influence on economic inequality, environmental change, and social stability. More recent works, such as those by Betts (2011) and Zetter (2018), have examined the implications of crisis-induced migration for host countries, particularly in terms of policy responses and the integration of migrants. These studies suggest that crisis migration presents both opportunities and risks for host regions, depending on the political, economic, and social context in which migrants arrive.

However, despite this growing body of literature, research gaps remain in addressing the long-term impacts of crisis migration on sustainable regional development. Pécoud (2014) and Hynie (2018) have argued that while migration can offer developmental benefits, these outcomes are often contingent on effective management and integration strategies. Moreover, recent trends highlight that while much attention has been focused on the Middle East and South Asia, emerging crises in Eastern Europe, such as the displacement caused by the war in Ukraine, have yet to receive adequate scholarly attention.

In addition to addressing these gaps, this paper draws on the work of scholars such as McAuliffe and Triandafyllidou (2021), who noted that the COVID-19 pandemic significantly altered the migration landscape, with new keywords and areas of focus appearing in the literature, including "health", "hygiene", and "pandemic migration". The research further explores how these events have led to an increased focus on migration governance, border control, and the socio-political dimensions of migration, as well as the role of international institutions in managing these crises.

Using WoS and Scopus data, this paper addresses research questions related to the current trends, subject areas, and terms in research publications on crisis migration, refugee migration, and sustainable regional development. In particular, this study highlights recent shifts in the field, such as the impact of geopolitical events like BREXIT, migration resulting from wars in Syria and Afghanistan, and the European Union's role in managing refugee crises. These shifts point to the evolving nature of migration studies and underscore the need for continued exploration of the intersection between migration, sustainability, and policy in times of crisis.

The findings of this study contribute to the growing body of literature on crisis migration and sustainable development, offering valuable insights into the directions of future research. Furthermore, this paper seeks to provide actionable recommendations for policymakers, NGOs, and international organizations working to address the challenges posed by migration in crisis contexts. By synthesizing current research and identifying gaps in the literature, this paper aims to guide future studies and provide a foundation for policy interventions that align migration responses with sustainable development goals (OECD, 2020). This study employs a novel approach to provide a comprehensive overview of the evolving landscape of crisis migration

research. It offers valuable guidance for future studies and practical insights for policymakers seeking to integrate sustainable practices into migration responses, effectively addressing both ongoing and emerging global challenges.

2. Material and methods

The article has undertaken to carry out a systematic literature review (SLR). SLR is involving an orderly, reliable synthesis of selected and collected research findings carried out so far. It can be the basis for building a new conceptual model or theory and mapping the development of a specific research field over time (Snyder, 2019). SLR is a process that involves a thorough bibliographic analysis of collected searches on a given topic that meet predetermined eligibility criteria to obtain answers to formulated research questions (Mengist et al., 2020). Our study consisted of three stages:

1. The first stage was carried out on February 14, 2023. It focused on two databases Web of Science (WoS) and Scopus, and a group of inquiries regarding the issues of crisis migration and sustainable regional development, presented in detail in Figure 1. These queries were entered separately into the WoS and Scopus databases.
   1.1. Web of Sciences, as a publisher-independent global citation database, covers almost 1.9 billion cited references from over 171 million records. It contains documents, described as the highest-quality and most impactful publications, identified from 1900 (Clarivate, 2023).

   Downloaded files result in a total number of 61 obtained documents. As part of this database, half of the documents were available as open access. Most of the documents were articles – 34 documents. Most of them were published in English (57 documents), Russian (2 documents), Slovenian (2 documents), and Czech (1 document).The authors of the documents represent a very diverse international group among which are representatives of Slovenia (6 documents); England, Germany, and Romania (6 documents each); Russia, Scotland, Slovakia, and Spain (3 documents each); Austria, Czech Republic, Italy, Mexico, Netherlands, Poland, and South Africa (2 documents each); Belgium, Canada, Croatia, Denmark, Estonia, Greece, Israel, Latvia, Luxembourg, South Korea, Sweden, Switzerland, Turkey, and USA (1 document each).

1.2. Scopus is a source-neutral abstract and citation database, that provides leading journal articles. It contains documents identified from 1970, covering over 1,8 billion cited references. 35% of the included documents are related to the field of social sciences (Elsevier, 2023a).

From this database, a total number of 84 documents were obtained. As part of this database, nearly 60% of the documents were available as open access. Most of the texts were also articles – 65 documents. Most of them were also published in English (67 documents), and the others were released in the following languages: Russian – 8 texts, Slovenian – 2 texts, French, Polish, and Spanish – 1 text each. Most authors of documents represented: Russian Federation and United Kingdom – 12 texts each; Germany – 10 texts; Romania – 7 texts; Italy and United States – 6 texts each; Slovenia – 5 texts; Austria, Poland, and Slovakia – 4 texts each; Australia, Netherland, Norway, Spain, and Sweden: 2 texts each; Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Greece, Hungary, Israel, Japan, Latvia, Luxembourg, Mexico, South Africa, South Korea, Switzerland, Turkey, and United Arab Emirates – 1 text each.

2. The second stage was to remove duplicates. In the case of both databases, 7 texts were duplicated. After removing them, 131 texts were qualified for the next stage (WoS: 54, Scopus: 77).
3. In the third stage, an analysis of the obtained documents using the VOSviewer program was undertaken. The software tool enables the construction and visualization of bibliometric networks and visualizes co-occurrence networks of given terms from scientific literature (Leiden University, 2023). It is effective e.g. for analyzing large amounts of scientific data. In addition, word cloud visualization was also used at this stage using the WordArt program.

The fully structured literature review process and the quantitative results obtained after the stages of selection are presented in Figure 1.

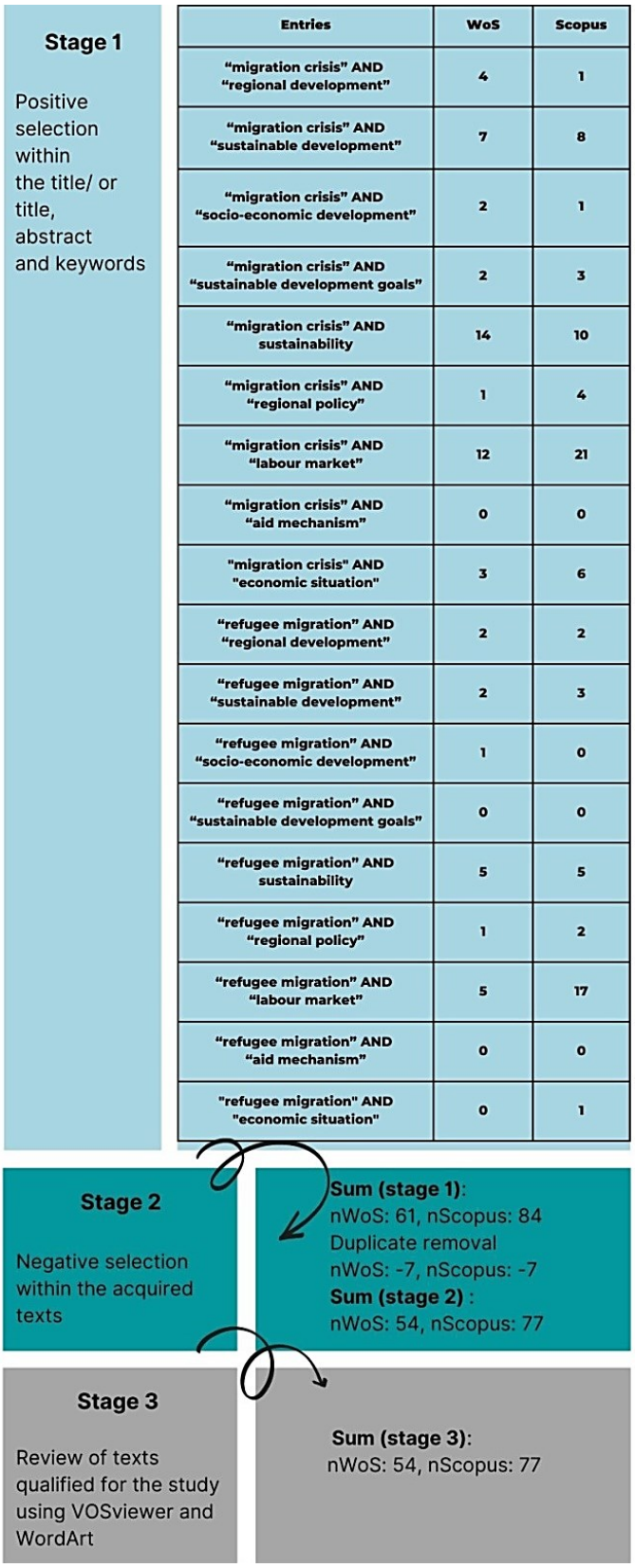


Figure 1. A structured literature review process and quantitative SLR results.

Source: own elaboration.

3. Results

3.1. Web of Science

As part of the WoS database, among the publications meeting our criteria, there were documents published between 2011 and 2022. The biggest publication wave achieved its peak in 2017 with 9 publications, and in 2020 also with 9 publications. Figure 2 presents the increased number of publications indexed in WoS within the researched area.

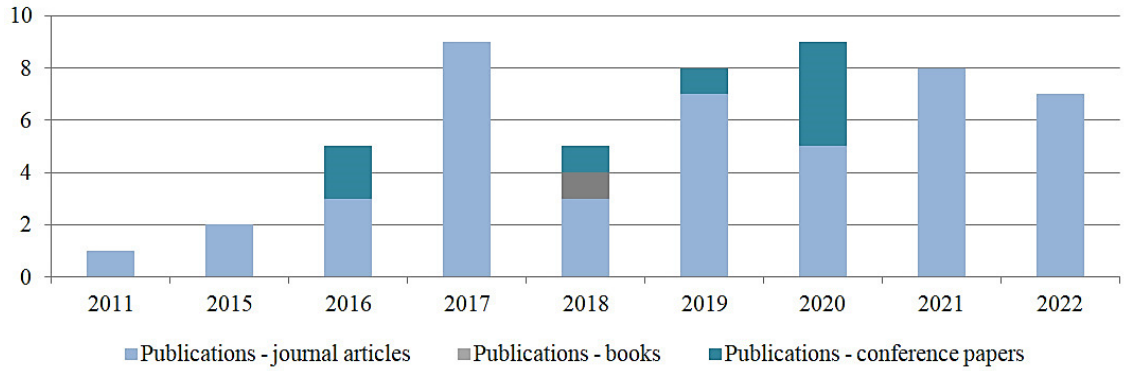


Figure 2. Number of publications indexed in WoS within the researched area 2011-2022).
Source: own elaboration.

After omitting the terms used in stage 1 of this study, within the titles of indexed documents, the most frequently appearing words turned out to be: market, policy, public, global, education, union, European, and labour. The titles contain also words referring to the great challenges of the 21st century - concerning spreading diseases: Covid (the word appeared twice), pandemic and HIV (both appeared once), the subject of economic integration: union (5 times), EU (3 times), BREXIT and Schengen (both appeared once), and people-to-people conflicts: war (appeared once). These words are shown in smaller font in Figure 2a, which presents the graphic visualization of words reflecting the frequency of occurrence of given words.

The articles appeared in print in 36 different journals, 8 conference proceedings, and 1 book. Within the journals, the most common were: Sustainability (5 texts), Mirovaya EkonomikaI Mezhdunarodnye Otnosheniya (3 texts), Sustainability, Baltic Region, Entrepreneurship and Sustainability Issues, and International Journal of Environment Research and Public Health (2 texts each). Figure 2b presents a word cloud for journal names of publications indexed in WoS.

a) b)

Figure 3. World cloud as map pin icon shows the most often appeared a) terms in titles, and b) journal names of publications indexed in WoS.

Source: own elaboration using WordArt program.

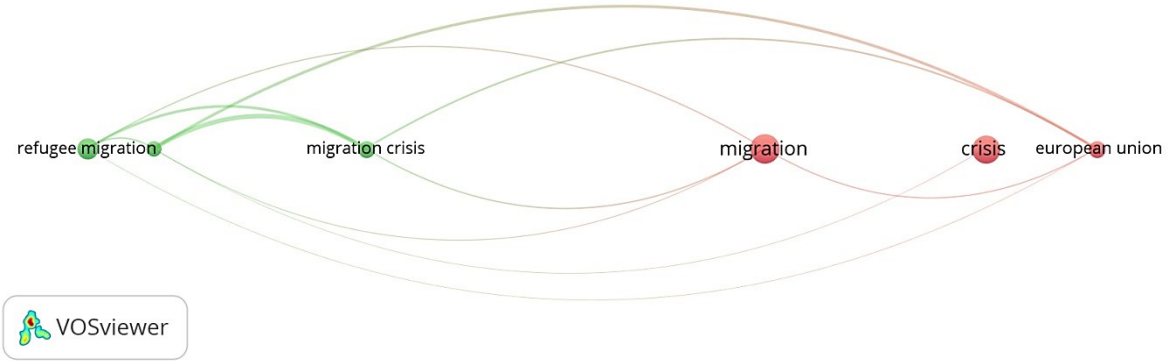
The VOSviewer tool was used to determine the number of authored texts and cooperation between the authors of the publication. The minimum number of documents of an author was selected as 2. Of the 136 authors, only 3 meet the thresholds: M. Banaś, C. Dustmann, and F. Fasani, of which the last two people collaborated once in conducting research and writing (Table 1).

Table 1.
Top three authors cooperating in contributing to research area within WoS

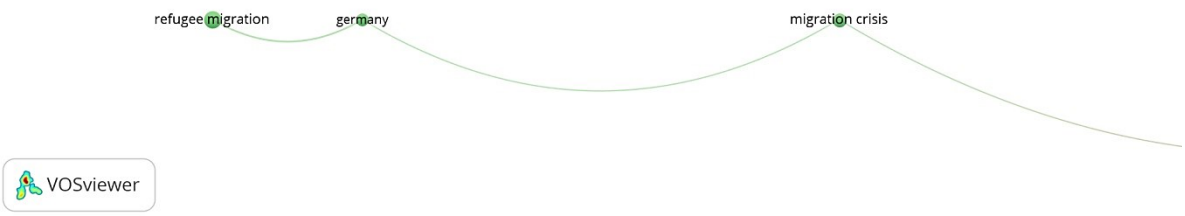
Author	Documents	Citation	Total link strength
Banas, M.	2	0	0
Dustmann, C.	2	0	1
Fasani, F.	2	0	1

Source: own elaboration.

To determine the coexistence of keywords used in the filtered articles, the VOS viewer was used again. The minimum number of occurrences of a term was selected as 3. Of the 195 terms, 6 meet the threshold. Two clusters were created: 1 (red) with 3 items – crisis, European Union, and migration; and 2 (green) with 3 items – Germany, the migration crisis, and refugee migration. In Figure 4, it is visible, among others, that the terms: migration and crisis (as the largest nodes) have the greatest importance within this topic. The lines between the nodes indicate the type of relationship between them. The relationship between term crisis is associated, for example, only with refugee migration. On the other hand, the relations between the migration crisis and Germany, as well as between the migration crisis and refugee migration, are the strongest within the framework mentioned.



a) Green and red clusters



b) Green cluster zoom

Figure 4. Network visualization based on WoS data.

Source: own elaboration.

Figure 5 shows the overlay visualization -the obtained terms over time. It follows, among others, the fact that the issues currently selected for research are related to the term Germany (marked in yellow), and refugee migration (green color). Another map in Figure 6 shows the density visualization - concentration of the obtained values. It shows that the terms migration and crisis are the brightest areas of the map -„the larger the number of items in the neighborhood of a point and the higher the weights of the neighboring items, the closer the color of the point is to yellow" (Van Eck, Waltman, 2018).

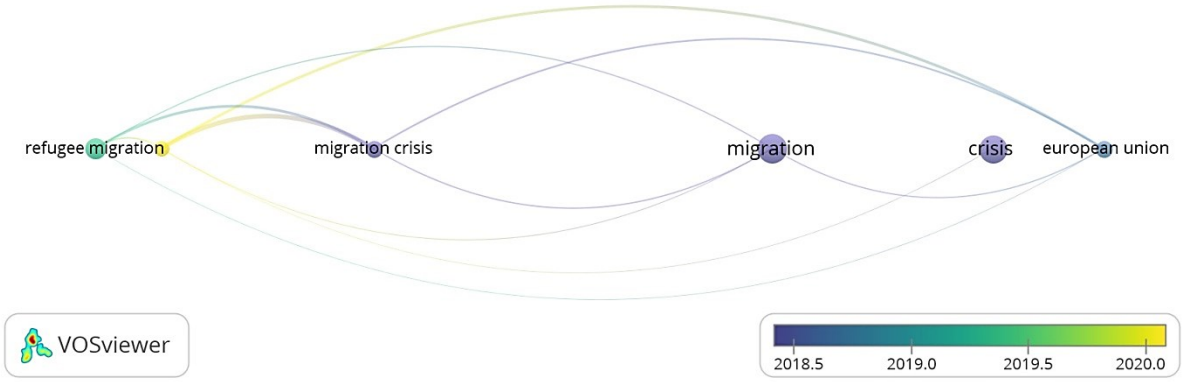


Figure 5. Overlay visualization based on WoS data.

Source: Own elaboration.

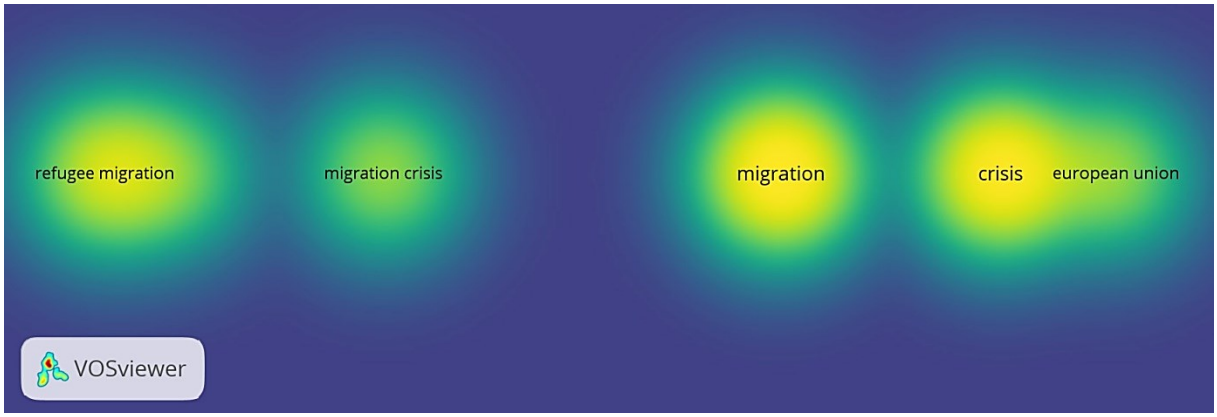


Figure 6. Density visualization based on WoS data.

Source: Own elaboration.

3.2. Scopus

As part of the Scopus database, among the publications meeting our criteria, there were documents published between 1989 and 2022. The biggest publication wave achieved its peak in 2016 with 11 documents, and in 2021 with 15 publications. Figure 7 presents the increased number of publications indexed in Scopus within the researched area in the period under review.

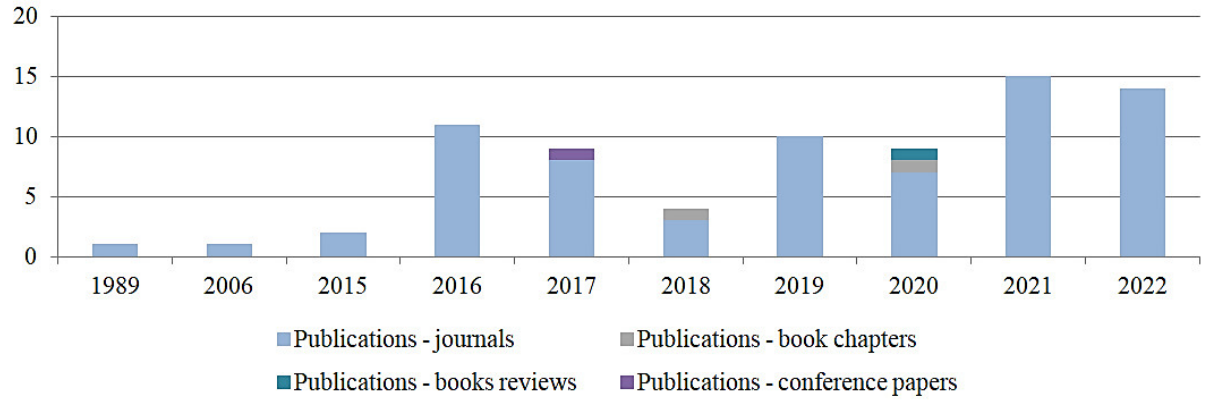


Figure 7. Number of publications indexed in Scopus within the researched area (1989-2022).

Source: own elaboration.

Within the titles of indexed documents, the most frequently appearing words turned out to be: integrate, policy, Europe, labour, market, international, effects, economic, Germany, EU, immigrants, borders, state, world, countries, region, labor, and develop. The titles contain also words referring to the great challenges of the 21st century - concerning spreading diseases: Covid (the word appeared twice), sanitation, hygiene, HIV, pandemic, and health (all appeared once), the subject of economic integration: EU (appeared 6 times), union (appeared 3 times), Schengen (appeared once), and people-to-people conflicts: war (appeared once). The most frequent references related to nationality were: Syrian (appeared 3 times), Romanian and Slovak (appeared twice). These terms are shown in smaller font in Figure 8a.

The articles appeared in print from 68 different sources. Among the journals, the most common were: Sustainability (Switzerland) (4 texts), World Economy and International Relations (3 texts), International Journal of Environmental Research and Public Health, International Migration Review, and The Lancet (2 texts each). Figure 8b presents a word cloud for journal names of publications indexed in Scopus.

a) b)

Figure 8. World cloud as map pin icon shows the most often appeared a) terms in titles, and b) journal names of publications indexed in Scopus.

Source: own elaboration using WordArt program.

The VOSviewer tool was used to determine the number of authored texts and the co-authorship of the publication. The minimum number of documents of an author was selected as 2. Of the 177 authors, 4 meet the thresholds: F. Fasani, T. Frattini, M. Roman, and G. Tyldum. The authors' productivity in terms of citations was also listed. F. Fasani and T. Frattini were the most frequently quoted – they scored respectively 93 and 90 citations. Table 2 shows the co-authorship within the scope of the Scopus database.

Table 2.
Co-authorship within the scope of the Scopus database

Author	Documents	Citations	Total link strength
Fasani, F.	2	93	1
Frattini, T.	2	90	1
Roman, M.	2	12	0
Tyldum, G.	2	3	0

Source: own elaboration.

The obtained data also made it possible to check countries' cooperation according to the co-authorship of the publications. The minimum number of documents of a country was selected as 5. Of the 37 countries, 6 meet the threshold (Figure 9) – they are countries with high productivity in terms of research work. This diagram shows that Germany, the United States, and the United Kingdom were types of bridges connecting scientists dealing with the issue of crisis migration and sustainable regional development. The geographical distribution of publications indicates that most publications on the subject of migration come from Russia, Germany, and United Kingdom. However, most cited papers come from the United States (Table 3).

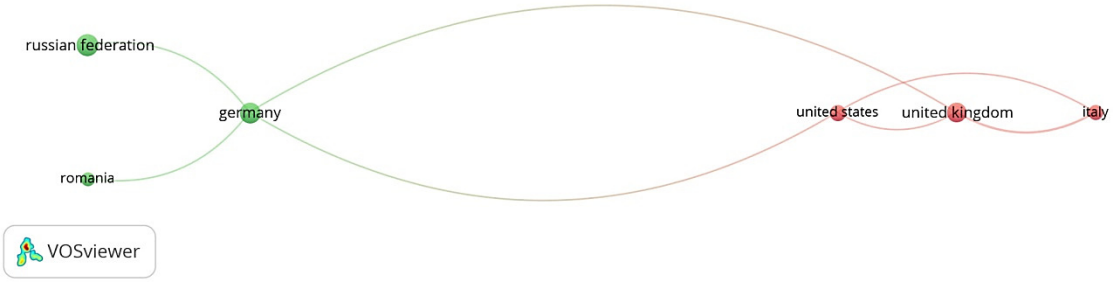


Figure 9. Map of relationships showing cooperation between authors from different countries, based on Scopus data.

Source: own elaboration.

Table 3.
Country cooperation within the scope of the Scopus database

Country	Documents	Citations	Total link strength
Germany	11	45	4
Italy	6	102	3
Romania	5	13	1
Russian Federation	13	17	1
United Kingdom	10	103	4
United States	7	134	3

Source: own elaboration.

To determine the coexistence of keywords used in the filtered articles, the VOS viewer was used again. The minimum number of occurrences of a term was selected as 10. Of the 2718 terms, 48 meet the threshold. Five clusters were created: 1 (red) with 15 items: *Afghanistan, country, crisis, immigrant, immigration, migration, the migration crisis, part, person, population, Russia, situation, state, world*, and *year*; 2 (green) with 12 items: *analysis, asylum seeker, effect, Germany, integration, labor market, number, order policy, problem, refugee,* and *refugee migration*; 3 (blue) with 10 items: *article, border, change, development, European Union, hand, Poland, research, role*, and *time*; 4 (yellow) with 8 items: *challenge, education, issue, migrant, paper, study, sustainability*, and *women*; 5 (purple) with 3 items: *Europe, need*, and *Syrian refugee* (Figure 10).

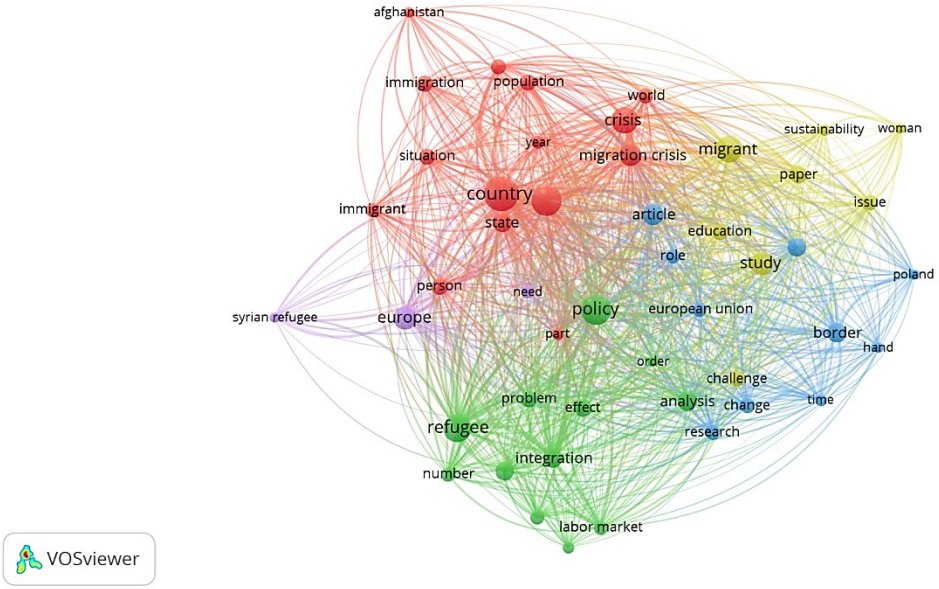


Figure 10. Network visualization based on Scopus data.

Source: Own elaboration.

The overlay visualization map (Figure 11) showing the distribution of the generated terms in time, indicates that most of the terms are assigned to years 2017 and 2018. Among the latest issues, a publications from 2020, related to the researched topic of crisis migration are the terms: *Afghanistan, Syrian refugee, refugee*, and *women.*

The density visualization map (Figure 12) shows that the best-explored areas are the following terms: *country, policy, crisis, refugee, migrant*, and *Europe*. The least visible fields indicate spaces that have not been given intensive research attention at present, such as the latest publication topics, i.e. items: Syrian refugee, Afghanistan, women, and Poland – which can be the possible directions for further research conducted on the topic of crisis migration and sustainable regional development.

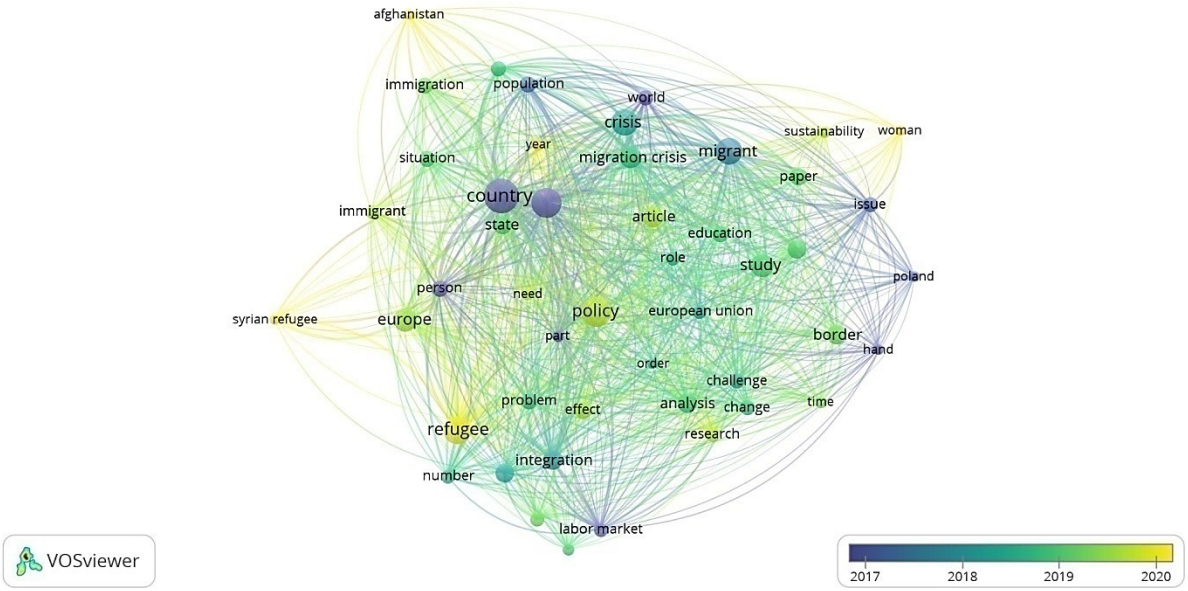


Figure 11. Overlay visualization based on Scopus data.

Source: Own elaboration.

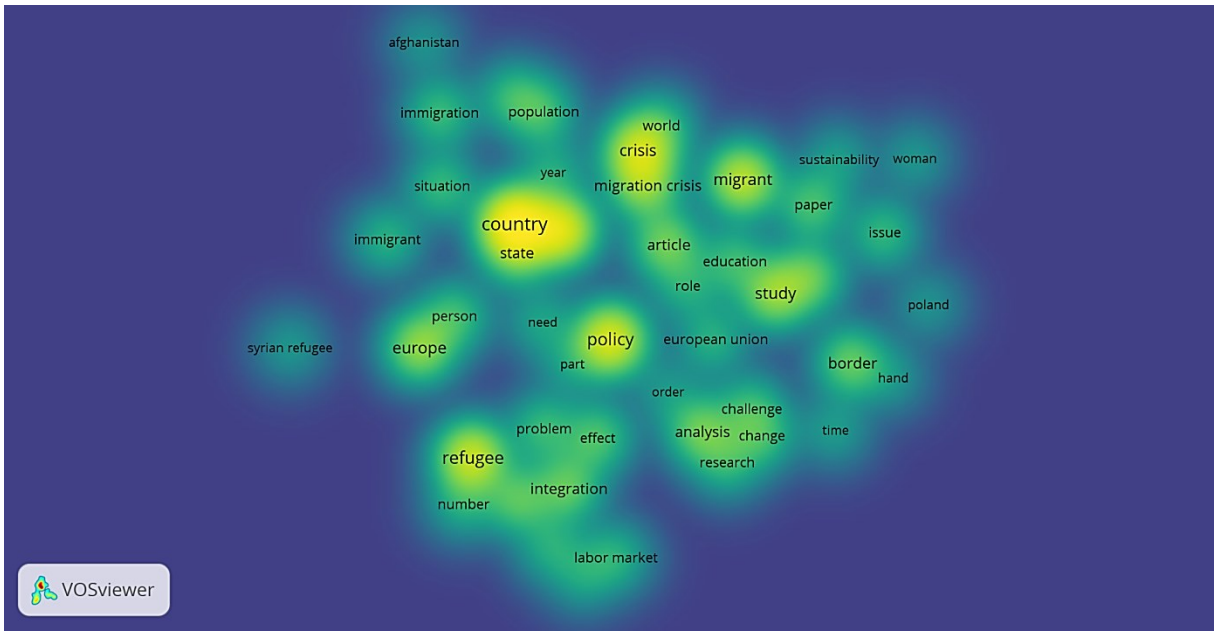


Figure 12. Density visualization based on Scopus data.

Source: Own elaboration.

Comparing the items listed as the newest (elements marked in yellow and bright green on Figure 11) and the least explored (Figure 12), the following items were qualified for further analysis: Afghanistan, Syrian refugee, Poland, Germany, Russia, European Union, asylum seeker, and women. In Figure 13a-h, maps of detailed connections for the listed terms are presented. Among them, the term Poland, although it is not often represented in texts indexed within Scopus, can be seen that it was chosen as the subject of researchers around 2017. On the other hand, the term women, which belongs to relatively new research topics, is directly related to the terms sustainability and Germany.

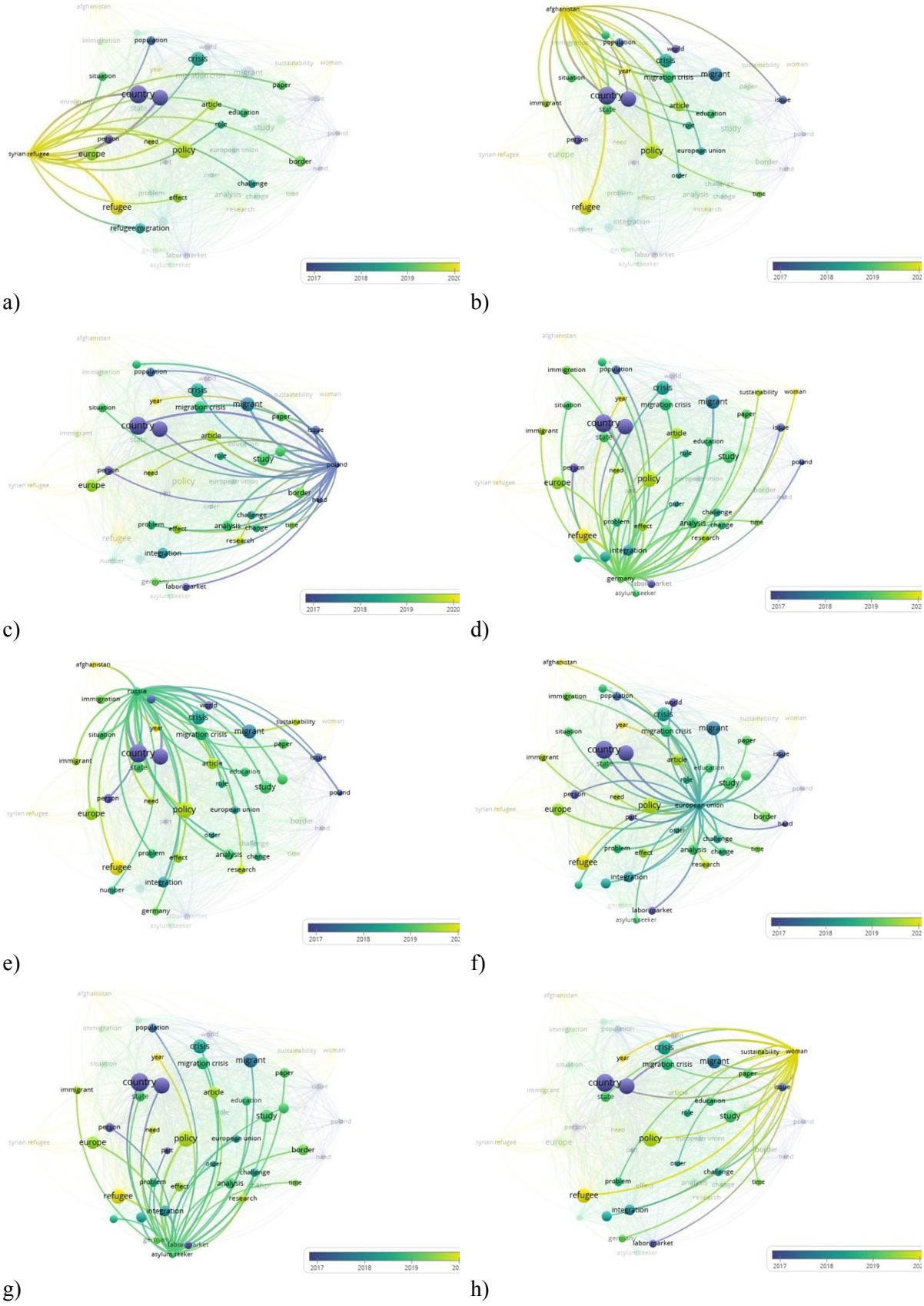


Figure 13. Relationships between items: 10a. Syrian refugee, 10b. Afghanistan, 10c. Poland, 10d. Germany, 10e. Russia, 10f. European Union, 10g. Asylum seeker,10h. women, and other items selected for the study based on Scopus.
Source: Own elaboration in VOSviewer program.

4. Discussion

The findings of this study reveal a clear upward trajectory in the volume of research on crisis migration, refugee movements, and sustainable development between 1997 and 2022 (WoS) and 1989 to 2022 (Scopus). This surge in publications highlights the growing recognition of migration as a critical area for research, particularly given its increasing complexity and its close ties to sustainable development objectives. Castles (2010) and Koser (2007) have long argued that migration and development are inextricably linked, with migration both influencing and being shaped by broader socio-economic and political dynamics. The upward trend in publications may also reflect the broader global political and environmental crises, which have made migration a focal point for academic inquiry, policy discussions, and public debate.

This study shows that the most frequent contributors to research on these topics come from Russia, Germany, and the United Kingdom, with the highest number of citations originating from the United States. This geographic trend aligns with previous research, which found that migration studies often focus on regions heavily impacted by refugee inflows and those that are central to international migration policies (Scholten, Penninx, 2016). However, recent shifts in global migration patterns, such as the Syrian and Afghan refugee crises, have increasingly driven research towards specific refugee groups, as documented by Betts and Collier (2017) and Zetter (2021).

A particularly striking finding from this study is the relative lack of research on the Ukrainian refugee crisis, despite its significant scale following the invasion of Ukraine in 2022. This may be attributed to delays in indexing articles in databases such as WoS and Scopus, which can take weeks or months to include new publications (Elsevier, 2021). These delays may also reflect a lag in the availability of relevant studies, as research on the Ukrainian refugee crisis is still in its early stages. As highlighted by Pécoud (2014), it is essential for migration scholars to rapidly respond to such emergencies in order to document and analyze emerging trends in real-time. However, as geopolitical priorities often influence which crises receive the most attention (Pécoud, 2014), it is also important to ensure that all migration crises are adequately represented in academic discourse.

This study reveals several important trends in the literature on crisis migration, refugee movements, and sustainable development. Key areas of focus include the intersection of migration and public health, the gendered dimensions of crisis migration, the impact of European migration policies, and the relationship between migration and sustainable development. Below, these trends are discussed in greater detail, along with an expanded exploration of recent research.

4.1. Migration and health in the context of global crises

The COVID-19 pandemic has had a profound impact on migration patterns and has significantly reshaped research into migration and health. In particular, the pandemic has highlighted the vulnerabilities of migrant populations, whose health and wellbeing are often compromised due to inadequate access to healthcare, overcrowded living conditions, and limited resources. The increased use of terms such as "pandemic", "health", and "hygiene" in migration studies underscores the growing recognition of the need to integrate health considerations into migration management (McAuliffe, Triandafyllidou, 2021). Migrants, especially those in temporary accommodation or refugee camps, face heightened exposure to infectious diseases due to poor sanitary conditions and lack of healthcare infrastructure (Hynie, 2018).

As McAuliffe and Triandafyllidou (2021) argue, the pandemic exacerbated the vulnerabilities of migrants by restricting access to essential health services and increasing discrimination and stigmatization. These challenges have prompted a call for more comprehensive policies that address the health needs of migrant populations, particularly in times of crisis. Scholars such as Koser (2007) and Castles (2010) stress the need for migration governance frameworks that prioritize health equity and provide essential services to migrants during health crises. Recent literature also suggests that migration policies should integrate health preparedness strategies to mitigate the impacts of future pandemics on migrant communities (Scholten, Penninx, 2016).

4.2. Gendered dimensions of crisis migration

Research on the gendered aspects of crisis migration has seen considerable growth in recent years, with a particular focus on the vulnerabilities of women and children in refugee and conflict settings. As Hynie (2021) notes, women refugees are often exposed to higher risks of sexual violence, exploitation, and discrimination, particularly in conflict zones. These vulnerabilities are further compounded by cultural and structural barriers that limit women's access to resources, legal protection, and integration opportunities (Zetter, 2021). Refugee women are often subject to gender-based violence, including sexual assault, forced marriages, and trafficking, exacerbating their already precarious situations.

This growing body of research emphasizes the need for gender-sensitive policies that consider the specific needs of women and children in refugee settings (Al-Husban Adams, 2016). Such policies must address issues such as access to healthcare, legal protection, and safe living conditions. Zetter (2021) underscores the importance of including gender considerations in refugee assistance programs, particularly in post-conflict settings where women often face heightened risks. Moreover, studies by Pécoud (2022) have suggested that gender-sensitive migration policies can improve both the short-term wellbeing and long-term integration of refugee women (Denaro, Giuffré, 2022; Gammage, Stevanovic, 2019).

4.3. Regional migration and European politics

Migration within and towards Europe continues to be a central focus of academic research, especially in relation to the ongoing crises in Syria, Afghanistan, and other conflict-affected regions. The European Union (EU) remains a key destination for migrants and refugees, which has led to the development of complex migration policies. Scholten and Penninx (2021) provide a comprehensive analysis of the political challenges faced by European states in managing migration flows. They argue that the EU's migration policies, which emphasize border control and the enforcement of asylum procedures, are often at odds with the need for effective integration programs.

Recent research indicates that EU policies have been both a source of protection and a cause of friction within host societies. For instance, while the EU's refugee relocation scheme was intended to share the burden of asylum seekers more equitably, it has faced significant political resistance in many member states, especially in countries like Hungary and Poland. Betts and Collier (2017) suggest that regional migration policies must balance the protection of refugees with the integration of migrants into local labor markets, education systems, and social structures. This balance is critical for achieving long-term social cohesion and stability in host countries.

Moreover, the European migration context is further complicated by the rise of far-right populism, which has influenced migration policies in many European countries. Research by Koser (2020) explores the political dynamics of migration in Europe, arguing that nationalism and anti-immigrant sentiment often shape policy decisions, with detrimental effects on migrant and refugee populations. Given the complexity of migration governance in Europe, there is a need for more research into how regional migration policies can be reformed to better meet the challenges of refugee integration while respecting human rights and international law.

4.4. Sustainability, migration, and development

In recent years, scholars have increasingly explored the intersection between migration governance and sustainable development, particularly in relation to the United Nations' Sustainable Development Goals (SDGs). Betts and Collier (2017) argue that migration can be an engine of economic development, both in host countries and countries of origin, provided that migration governance frameworks are designed to foster integration and support the long-term development of migrant populations. However, achieving this vision requires overcoming significant obstacles, such as resource constraints, political opposition, and the need for international cooperation.

Recent studies by Pécoud (2014) emphasize the importance of developing sustainable migration practices that contribute to both the economic development of host countries and the wellbeing of migrants. These practices include promoting social inclusion, improving access to education and healthcare, and ensuring that migrant labor is integrated into the local economy.

Such policies not only improve the lives of migrants but also benefit host societies by boosting productivity and fostering social cohesion.

Moreover, sustainable migration practices can play a key role in achieving the SDGs, particularly Goal 10 (Reduced Inequalities) and Goal 16 (Peace, Justice, and Strong Institutions). By ensuring that migration is managed in a way that benefits both migrants and host communities, governments can contribute to the achievement of these goals, while also fostering greater global solidarity in addressing the challenges posed by migration.

Table 4.
Key research trends in crisis migration, refugee movements, and sustainable development

Research trend	Key findings	Key authors
Migration and health	Focus on the intersection of migration and public health, particularly during global crises such as the COVID-19 pandemic. Concerns include the spread of diseases, inadequate healthcare access, and the heightened vulnerability of migrants. Significant attention is given to migrant health needs, mental health challenges, and the role of healthcare systems in managing the influx of migrants during health crises.	Mladovsky et al. (2012), McAuliffe, Triandafyllidou (2021), Bojorquez et al. (2021), Willen et al. (2021), O'Donnell (2018).
Gendered dimensions of crisis migration	Gendered vulnerabilities in crisis migration, with women and children facing higher risks of sexual violence, exploitation, and discrimination, particularly in refugee camps or conflict zones. The importance of addressing gender-specific needs in migration policies and the development of protective measures is highlighted.	Hynie (2018), Zetter (2021, 2007), Lama, Hamza, Wester (2021), Denaro, Giuffré, (2022), Gammage, Stevanovic (2019), Ghosh (2009).
Regional migration and European politics	In-depth exploration of migration trends within Europe, including the political challenges surrounding asylum seekers, border control, and refugee integration. The impact of EU policies, such as the Schengen Agreement and the Dublin Regulation, on migration patterns is analyzed. Research also touches upon the rise of nationalism and political resistance to refugee policies in various EU member states.	Scholten, Penninx (2021), Betts, Collier (2017), Maruszewski, Kaczmarczyk (2020), Górny, Kaczmarczyk (2020)
Sustainability and migration governance	Examination of the relationship between migration and sustainable development, particularly how migration can be incorporated into long-term development strategies that align with the United Nations Sustainable Development Goals (SDGs). Focus on the importance of inclusive migration governance and the role of migrants in contributing to the socio-economic development of host countries, without overburdening local resources.	Betts, Collier (2017), Pécoud (2014), Rother (2019), Martin (2022), Castles (2009), Al-Husban, Adams (2016), Holliday et al. (2019), Adger et al. (2019)
Economic impacts of migration	Research on the economic contributions of migrants to host economies, including the labor market, innovation, entrepreneurship, and economic growth. The studies analyze how diversity within the workforce can drive economic performance and competitiveness, with a particular emphasis on migrant workers in key sectors. Issues of remittances and migration's impact on global trade are also addressed.	Dustmann, Frattini (2014), Clemens (2013), Borjas (2017), Al-Husban, Adams (2016)
Climate change and migration	Exploring the role of environmental factors in migration, particularly in the context of climate change. Research examines how environmental degradation and extreme weather events drive migration flows, particularly in vulnerable regions. The implications of climate-induced migration for policy and security are considered.	McLeman (2013), Black et al. (2011), Lama, Hamza, Wester (2021), Piguet, Pécoud, De Guchteneire (2011), Kaczan, Meyer (2020).

Cont. table 4.

Urbanization and migration	The interplay between migration and urbanization, focusing on the challenges and opportunities presented by the influx of migrants into cities. Studies examine urban infrastructure, housing, social services, and the integration of migrants into urban communities, with special attention to the development of inclusive urban policies.	Sassen (2013), Moser (2020)

Source: own elaboration.

Generally, the research highlights several emerging trends in the study of migration and sustainability. There is a growing recognition of the intersection of health and migration, with particular attention to migrant health vulnerabilities during crises. As McAuliffe and Triandafyllidou (2021) note, the COVID-19 pandemic underscored the critical need for robust health systems to address the specific vulnerabilities of migrants, particularly during global health emergencies. Gendered impacts are also a prominent focus, with the need to develop policies that consider the specific needs of women and children in migration settings (Ghosh, 2009; Hynie, 2018; Zetter, 2021, 2007). Zetter (2021) emphasize that women refugees face heightened risks of violence and exploitation, necessitating gender-sensitive policy responses.

Furthermore, the relationship between migration governance and sustainable development is gaining traction. Betts and Collier (2017) highlight the potential for integrating migration policies with broader sustainable development frameworks to achieve long-term socioeconomic benefits for both migrants and host communities.

However, important gaps remain in the literature. As noted by McLeman (2018), there is a lack of research on the impacts of migration induced by environmental factors, particularly climate change. Black et al. (2011) further argue that climate-induced migration is often underrepresented in global policy discussions despite its increasing relevance. Moreover, the ongoing crisis in Ukraine, with its significant migrant flows, has not yet been sufficiently addressed in the academic literature. This is likely due to the time lag in publication indexing in databases such as WoS and Scopus, as previously observed by McAuliffe and Triandafyllidou (2021).

This underscores the importance of timely research responses to emerging migration crises. Sassen (2013) emphasizes the need for agile and adaptive governance frameworks that can respond effectively to the multifaceted challenges of global migration. Such frameworks must integrate health, gender, and sustainability dimensions to address the complex realities faced by migrants and host communities alike.

By addressing these gaps, future research can contribute to the development of more effective, humane, and sustainable migration policies.

5. Summary

The purpose of the article was to define current trends, subject areas and terms in research publications on crisis, refugee migration and sustainable development, as well as recent issues, challenges and future trends in this area. In the case of both databases, there is an upward trend in the number of documents, which allows for a conclusion about the increase in research interest in this topic in the period 1997 to 2022 for WoS and 1989 to 2022 for Scopus. Publications within the database Scopus indicate that most documents of the issues studied come from Russia, Germany, and the United Kingdom. While the most cited papers come from the United States.

The changes occurring over the last two years, primarily the SARS-CoV-2 pandemic (December 2019), have been marked by the appearance in scientific texts of the words: Covid, pandemic, hygiene and health and within the area of international integration: union, European Union, BREXIT and Schengen, as well as migrations resulting from conflicts between given social groups: war, Syrian refugee and Afghan. The lack of a topic dedicated to Ukrainian refugees, related to the war started by Russia, which has been ongoing since February 24, 2022, was observed. This may be related to the fact that a publication appearing in print is not immediately indexed in WoS and Scopus, and may be associated with a longer period between its publication and actual appearance in the databases. However, according to the information provided by the Journal Article Publishing Support Center (Elsevier, 2021), it takes 4-8 weeks from the publication of the issue to the indexing of the text. In the case of Scopus, the document is usually indexed within four days (Elsevier, 2023b). However, when analyzing the entries (asked questions and answers) of scientists active within Research Gate, one can get the impression that indexing takes a little longer, even up to two months. It can also mean that texts devoted to this issue appear mainly in journals not indexed or awaiting acceptance by WoS or Scopus.

Recent trends indicate research interest primarily in topics: Syrian refugees, Afghan and women. Key aspects that can be possible directions for further research conducted contain also terms: German, Russia, Poland, and asylum seeker.

The results of our research may prove helpful to the scientific community, and the indicated trends may contribute to directing their work on the above-mentioned issues and obtaining significant results. In addition, they may also prove helpful for state authorities responsible for implementing policies related to population migration and for introducing sustainable practices - the implementation of sustainable development goals.

5.1. Limitations of the study

The limitations of this study include the following, using:

- only two databases → which eliminated many high-quality documents that are indexed in databases less popular in social sciences, or databases from which it is currently not possible to easily obtain files for analysis as part of the soft tool used,
- databases where not all publications on crisis migration, refugee migration and sustainable regional development are indexed → which eliminates many high-quality works published in regional journals,
- databases in which the dominant language of publication is English → which eliminates many high-quality texts published in less popular languages,
- narrow search criteria (stage 1) → which may exclude some of the documents devoted to the studied area (it is however one of a characteristic feature of SLR).

In general, this study offers a comprehensive review of the current state of research on crisis migration, refugee movements, and sustainable development. It highlights several key trends, including an increasing focus on health and gender in the context of migration, the continuing prominence of European migration patterns, and the integration of migration governance with sustainability. However, important research gaps remain, particularly regarding the Ukrainian refugee crisis and the longer-term impacts of crisis migration on host regions. As migration crises continue to unfold worldwide, it is crucial for both researchers and policymakers to address these gaps and ensure that migration is integrated into sustainable development frameworks in a timely and effective manner.

Further research is needed to deepen our understanding of these interconnected issues and to inform more effective, humane, and sustainable migration policies.

Acknowledgements

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PERSONAL DEVELOPMENT OF UNIVERSITY TEACHERS AS A FACTOR IN PREVENTING PROFESSIONAL BURNOUT IN THE PERSPECTIVE OF STAFF MANAGEMENT

Joanna M. ŁUKASIK

University of Agriculture in Krakow; joanna.lukasik@urk.edu.pl, ORCID: 0000-0001-5530-5109

Purpose: the article focuses on activities implemented as part of the Regional Initiative of Excellence (RID, *Regionalna Inicjatywa Doskonałości*) project for supporting academic staff development in one of the universities in southern Poland. One of the project goals is to identify the needs of university staff members, especially their self-realization needs in the context of supporting their well-being and satisfaction from work and personal life.
Design/methodology/approach: the goal of the article is to present assumptions and implementation of one of the tasks within the RID project, namely, innovative activities to strengthen the human potential by completing specific tasks designed as a response to the staff members' individual needs.
Findings: the main findings derived from the analysis concern the following issues: (1) Recognition of Personal Development Needs; (2) Burnout Prevention through Self-Care; (3) Correlation between Personal and Professional Development; (4) Sustained Organizational Impact; (5) Innovative Practices and Future Plans.
Originality/value: both individually targeted activities and system solutions introduced to the university structure, involving support, development and psychological assistance in crises, are presented.
Keywords: personal development, academic teacher, professional burnout, human resource management.
Category of the paper: Conceptual paper.

1. Introduction

A university is an institution oriented on the development of individuals and scientific disciplines. When referred to scientific discipline advancement, individual development focuses on both university staff and students who attend the university courses to improve their knowledge, skills in the disciplines they are interested in and social competence. In this context, the following statement by Irena Wojnar can be applied, who sees modern education as care manifested "in searching for ways to improve the quality of the world and humans in their

mutual interaction. Education is fundamentally connected with an opportunity for development, creative activities and self-realization (Wojnar, 1996, p. 18). In the university environment, teachers bear a particular responsibility for the quality of their knowledge, their predispositions to transfer this knowledge and skills used to conduct research and teach the students. It means that university teachers who are aware of their profession and responsibilities, professionals (experts in their disciplines), explorers and researchers, inspire and motivate others, both students and other staff members, to grow. With such an approach to university, it can be called a community "woven of shared and mutual care... care and responsibility for equal right to be a human and equal opportunity to act accordingly to this right" (Bauman, 2008, p. 200). These words were an inspiration to investigate university activities that were motivated by this shared and mutual care for the development of academic teachers; the development regarding not only their professional activity and specific disciplines but also personal growth which helps them be humans who work as teachers in the university environment.

This article focuses on the nature of functioning of academic teachers in the university environment in the context of opportunities for personal development motivated by care for their mental health and prevention of burnout. Some good practices in this area are presented, implemented in one of the universities in southern Poland as innovative activities resulting directly from effective management of human resources in a higher education institution.

2. Academic teacher in university environment

Despite being an integral part of today's life, dynamic social, cultural, civilizational or technological changes and constantly new expectations, challenges and requirements they place on the representatives of social professions, academic teachers in particular, make them experience the psychological costs of their work ever stronger. These costs manifest themselves as emotional exhaustion, depersonalization and, eventually, professional burnout. Thus the dynamics of change affects the functioning of academic staff members and, consequently, the university itself.

According to Maria Czerepaniak-Walczak, what is of particular importance for today's university is the "focus on 'concentrating' that what matters in a university: research and education of critically thinking individuals, formation of intellectual capital and development of academic culture based on personal and generalized trust" (Czerepaniak-Walczak, 2014, p. 18). This is the responsibility of academic staff members ("homo academicus") whose activities are "a commitment and a challenge" (Czerepaniak-Walczak, 2014, p. 18). "Homo academicus" is "focused on accumulating and managing of the academic potential in which they invest their personal time. It is expressed in their work which involves creation of intellectual instruments which are also social instruments of academic power (lectures,

textbooks, dictionaries, encyclopedias etc.) and, above all, creation of academic achievements and representation which contributes to the accumulation of symbolic capital in the form of external recognition" (Czerepaniak-Walczak, 2014, p. 18). Thus, university teachers focus mainly on their research, development of science and dissemination of results, as well as on didactic activities. "This is what they spend their time on. This is the essence of academic power, capital and habitus. Autonomy, freedom of speech, mutual trust and intellectual support is homo academicus' environment. However, in this environment, there is also oppression, enslavement, competition and peculiar corruption" (Czerepaniak-Walczak, 2014, p. 18). Józef Górniewicz (2014, pp. 144-145) says that "It is people in the first place that create the unique atmosphere of research work — outstanding personalities, leaders of opinion or contrary, marauders, sceptics and critics of both workplace conditions and organizational climate in an institution. They decide about the success or, sometimes, the failure of certain research projects. They create the atmosphere that favors scientific work or the one that is unfriendly, full of tensions, pretense, gossip, slanders or envy about the successes of others" (after: Czerepaniak-Walczak, 2014, p. 19). So, in the university, in addition to positive experiences, there are also destructive ones that hinder work and growth, promote competition, chase for ranks, escape strategies which minimize the consequences of being overloaded with scientific and teaching requirements work (preparation and delivery of lectures, verification of learning outcomes, too many administrative tasks and excessive bureaucratization of research and teaching activities). These strategies can be more or less general: from being unprepared to teach certain classes and providing low quality teaching, to committing fraud in scientific work by adding one's name to other's publication to avoid N = 0 classification in the discipline one represents, etc. Functioning in such a work environment and using destructive strategies to deal with the requirements "are factors which limit the sense of security as well as effective and satisfactory membership in the academic community. Interpersonal relations and mechanisms that govern promotions and financing of research also have this kind of enslaving power that hinders individual and group research initiatives" (Czerepaniak-Walczak, 2014, p. 19). These and multiple individual destructive experiences and pathological situations in the workplace, reinforced with the sense of lack of meaningful achievements, prospects for promotion, satisfaction from teaching and research efforts; excessive administrative duties and constantly new socio-cultural phenomena introduced by the students (new communication styles, different value system, psycho-emotional disorders, problems with communication etc. – for which the academic teachers are not always prepared) turn work in the source of stress and, eventually, burnout. Pines & Aronson (1981) notice that professional burnout is an ongoing process in which a person's psychical and physical capacity (resources) is gradually depleted. Because of this, they cannot see prospects or opportunities for further professional development and their efforts do not give them satisfaction or even joy. This condition is caused by a discrepancy between that person's role as an employee and requirements set by the hiring organization.

Therefore, as emphasized by Helena Sęk (2000), professional burnout is a sequence of relationships caused by factors found in the employee as well as in the surrounding environment. And the consequences reveal themselves as depletion of the person's individual resources and their reduced ability to function in the emotional and interpersonal sphere as evidenced by emotional exhaustion, depersonalization and low self-esteem (Ogińska-Bulik, 2003; Maslach, 2001). In the final stage, it leads to aversion and withdrawal from the professional activity (Tucholska, 2003).

Numerous studies into burnout indicate that it is the most serious psychological consequence of occupational stress. Two factors most often listed as affecting the type and intensity of stress symptoms and determining the level of burnout are: stressful working conditions and individual aptitudes.

The first category includes: excessive demands from the hiring institution and a constraint to cope with a difficult, stressful situation; work overload; necessity to make decisions under the pressure of time; responsibility for others; conflicts associated with certain role/position; unstable employment conditions; degradation of social status (Ogińska-Bulik, 2003). The other category usually includes: personality factors; stress coping strategies; personal resources such as the sense of self-esteem, self-effectiveness, self-agency, coherence and optimism (Ogińska-Bulik, 2003). Employees who struggle with burnout show: fatigue, loss of self-esteem, sadness, lack of satisfaction, frustration, irritability, stiffness, fear, inability to evaluate their effectiveness objectively, denial as well as somatic symptoms like headaches, back pain and gastric diseases (Grzegorzewska, 2019). According to Tucholska (2003), symptoms noticeable in people who experience burnout include: depression, anxiety, mood swings, fear, sense of failure and being trapped, constant guilt and focus on self accompanied by the sense of not being accepted.

In addition to psycho-somatic and personal loss outside of work (greater irritability, quarrelsomeness or exhaustion), the consequences of burnout are also visible in the professional sphere. It manifests itself as: withdrawal from professional activity, increasing absence, decreasing working hours or constant readiness to neglect professional duties (Tucholska, 2003), minimum performance and negative attitude towards initiatives aimed at improving the effectiveness and quality of work. The work itself is negatively evaluated by supervisors, which reinforces the employee's psycho-emotional condition, dissatisfaction, lack of bonds with the workplace and coworkers (Maslach, Leiter, 2001) and (in case of university teachers) students.

In the light of the above, initiatives to prevent burnout of academic teachers are extremely important. One of them is education in the area of self-care and finding time and space in one's life for personal growth, e.g. for nurturing passions and talents not related to work. It is a sign of self-care and intentional efforts made to prevent professional burnout.

3. Personal development as a sign of self-care

When analyzing the literature on the subject, one can read Judith Phillips who says that self-care means a state of concern about self (2009, pp. 22-23) emerging from the need to take care about one's well-being. From the perspective of this article, this category of "self-care" is of particular importance. Hanna Stępniewska-Gębik (2011, pp. 26-35) identifies several components of it. The first component is connected with a general attitude towards the world, others and self. The second component includes focus on self, reflections over one's own actions and thoughts. The last component refers to specific work on oneself, "activities directed on ourselves, for which we take responsibility; in these actions we modify, transform, correct etc. ourselves" (Stępniewska-Gębik, 2011, p. 33). According to this author, the result of care viewed by the acting individual as a specific type of self-experience, discovering truth about self through examination, practice and reflection that leads to this individual's interactions with themselves. Such care, in Foucault's perspective, is not motivated by egoism but rather is "a work on the self in a constant connection with social life... Self-care becomes an ethical work on the self, on constituting oneself as a subject of ethical actions" (Stępniewska-Gębik, 2011, pp. 34-35). It is also important that self-care allows people to ask fundamental questions that "determine their individual position toward others in the society, towards the roles they play... Self-care helps them deal with difficulties resulting from both developmental or existential changes and changes caused by adverse or crisis situations" (Stępniewska-Gębik, 2011, p. 34). Thus, self-care motivates activities which facilitate personal growth and, at the same time, it is a source of coping with that what is new, unknown and caused by the change that accompanies development.

Personal development is, therefore, an important area of existential self-care – in the context of this article, self-care of university teachers. The essence of their work is constant scientific, research and didactic development which is, at the same time, a source of motivation for others, both fellow coworkers and students. Thus, it can be assumed that development is an integral and fundamental aspect of their professional role. But as they engage in multiple developmental activities which are subject to external evaluation (e.g. evaluation of achievements by supervisors, evaluation of classes by students, evaluation of work by promotion committees) do university teachers have time and space to execute self-care and invest in their personal development outside the academic activities, evaluation and control? And if not, where do they seek resources and support to neutralize tension experienced at work? In this article, initiatives to support personal development of academic teachers, introduced as part of the Regional Initiative of Excellence (RID, Regionalna Inicjatywa Doskonałości) project are presented. They are rooted in both theoretical concepts presented above (professional burnout, personal development) and conceptual thinking resulting from pedagogical studies (homo academicus, university). One of the concepts that underlies the activities implemented in the RID project

(Area III, described further in the article) is the concept of teacher development by Jim Butler (1995). Butler says that personal development is a basic and a necessary precondition for a better quality life. It can be added that for adults who function in different areas, personal growth becomes also a necessary condition of professional development. There will be no intentional professional development without intentional personal growth (pp. 155-156; see also: Gaś, 2001). Research by Kazimierz Obuchowski (1993) indicate that development begins when a person realizes and outlines their own concept of "the self and the world" and focuses on "creative processing of the knowledge possessed" (p. 33). This follows an awareness (self-knowledge) of "who we are and what conditions we can and want to transform into realization of ourselves" (p. 33). Thus, the necessary preconditions for personal growth which is the basis of professional development are: self-cognition (Dziemianowicz-Nowak, 2008), self-evaluation resulting from an adequate view of the self (Kozielelecki, 1981), goal-orientation understood as finding the meaning of existence and activity (Frankl, 2003), experienced self-efficiency (Sęk, 1991), inner motivation, control (Rotter, 1990) and other. This leads to a conclusion that persons with the above listed characteristics and in the above mentioned conditions, who care for their well-being and maintain balance between that what matters to them as human beings and that what is important for their social roles, engage in developmental activities in different spheres of their lives (e.g. physical, mental, professional, spiritual, social, family, intimate). But the balance can be maintained by those who focus on development, know their needs and potential, have passions, can manage their time and potential, take on self-care actions to improve their well-being in order to have energy to stay active in other areas (professional, family etc.). Self-care empowers individuals to act with less strain and effort, enables better organization of work and better results. This, in turn, translates into satisfaction with life and work, and increases motivation to effectively pursue personal and professional goals (cf. Seiwert, 1998, p. 14). So, thanks to personal development motivated by self-care, academic teachers can better (or ever better) and more effectively recognize and understand themselves, intentionally choose their own life path according to their needs, aspirations, motivations and the ways to address them" (cf. Dziemianowicz-Nowak, 2008).

Given the above, in one of the universities in southern Poland, an approach has been adopted that self-care expressed in personal growth oriented on developing passions, dreams and talents, is a burnout prevention factor. This approach inspired an implementation of a multiple-stage innovation financed as part of the RID project. It was based on the assumption that the value of development – located outside work – becomes a protective buffer for people. "The more people begin to notice that development helps them better understand themselves (including recognizing and appreciating their strengths, weaknesses, passions, values, goals and dreams), the more effectively they develop different skills necessary to achieve goals, the better are their relationships with others (partners, spouses, parents, friends, coworkers, children) and the better is their health and general well-being (as they manage stress better, take care about their body and mind, live healthier)" (Łukasik, 2024, p. 9).

4. Personal development of academic teachers as an innovation in university staff management

There are no research on personal development of academic teachers in Polish scientific publications, the existing texts focus on scientific development and promotions (e.g. Brzeziński, 2017, Śliwerski, 2019; Kierznowski et al., 2021). The theoretical and conceptual assumptions presented above were taken into account on the project titled "Greater potential of management and quality sciences through better use of the capital of Polish countryside" financed from the state budget as part of the program of the Minister of Science "Regional Initiative of Excellence" (RID, Regionalna Inicjatywa Doskonałości), to be implemented in 2024-2027 in one of the universities in southern Poland. Four key areas have been identified in the project, of which "Area III: Interdisciplinary approach to university staff management" is dedicated to scientific research and implementation of innovative activities addressed to the university staff members as a response to conclusions from a study aimed at diagnosing the developmental, educational and self-realization needs of the research staff.

Implementation of tasks in this area began in January 2024, therefore in this article, only completed and evaluated actions to facilitate personal development of academic staff members will be presented.

The goal of these actions was to: 1. Stimulate inner motivation to take actions that facilitate personal development; 2. Recognize personal development needs; 3. Diagnose job satisfaction in order to take actions preventing professional burnout; 4. Provide psychological support for academic staff members – personal development workshops and psychological support in case of exhaustion or burnout.

For the university management, the realization of the above mentioned goals is a valuable source of information about job satisfaction and self-realization needs, which additionally enables more effective management of individual potentials and modification of activities according to changing/improving work conditions.

The following action steps were taken:

1. Scientific seminar with an lecture to introduce discussion on: "Personal and professional development of academic teacher – on the way to success". The goal was to recognize the staff's developmental needs and motivate them to active participation in such initiatives as: preparation of self-development textbook and development workshops. The seminar provided some basis for the concept of the textbook and workshops.
2. Research project: „Job satisfaction and risk of professional burnout among university staff". The project is theoretically grounded in the conceptual models for each specific category. Job satisfaction is understood as a personal feeling interpreted in emotional, cognitive and financial aspect (Zalewska, 2003; Herzberg, 1966; Paliga, 2021) and for this reason, a range of satisfaction determinants were considered. Burnout was defined after Maslach (1994). The project was embedded in the HR Management model and

Organization Management model in the context of effective management determinants in Herzberg's model. The investigations (using standardized research tools, including: Self-Evaluation Scale SES, Minnesota Satisfaction Questionnaire MSQ, SSP, OLBI, PER) enabled a diagnosis of the sense of satisfaction from work, self-evaluation and educational and developmental needs of the academic staff members for effective management and implementation of actions to prevent burnout or (in case of diagnosed burnout) implementation of effective supporting, intervention, therapeutic etc. actions to improve the management of both staff development processes and organization itself. The main goal of the study was to: identify relationship between job satisfaction and professional burnout among the university staff.

3. Textbook titled "Personal Development. Effective Self-Management" dedicated to academic teachers, intended as a set of exercises for adults, with instructions for individual work. It is treated as an inspiration for the readers and invites them to a journey into themselves as part of self-care, to experience the adventure of discovering and designing themselves and their own development. The exercises are organized and designed in a sequence that guides the readers on their way to personal growth. The textbook begins with exercises that help recognize one's own resources, potential and abilities, then focus on developing and using reflections, and stimulating inner motivation (shaping inner-direction), then on designing one's own development through intentional formulation of short- and long-term goals and effective time management, and finally, on effective communication of needs and communication focused on building positive relationships with self, with others and with the world.
4. Personal development workshop: "Personal Development – Effective Self-Management". The purpose of the workshop was to: motivate to personal growth and, consequently, to improve the quality and effectiveness of functioning in personal and professional life (strengthen the positive organizational culture of the University by supporting and developing resources and potential of the university staff). The workshop focused on the following growth areas: a) Personal (including: awareness of strengths, direction of the development of own potential, ability to care about own needs, rules, free time and rest) and b) Socio-Emotional – important for building a positive work and study space in the University (including: using resources to improve one's own functioning in the University environment, using development tools during teaching activities with the students). The workshop was conducted in three groups (3.5% of the academic staff members participated). Each group followed an individual workshop program adapted to their needs, consisting of three modules (each module took 3 hours). A feedback was obtained about the participants self-evaluation, motivation to change and important areas of personal development. This information will be used to design workshop in the next calendar year (for those who have already participated and for new groups; there will be 6 groups in 2025).

5. Innovations for personal development and improvement of well-being of the academic staff (including access to psychological support and supervision). At present, personal development workshop for academic staff members are implemented on a permanent basis. Other innovations will be introduced accordingly to the needs signaled, the diagnosed job satisfaction (or the lack of it) and the sense of exhaustion or burnout (implementation activities for 2025-2027).

5. Summary

Management of the potential of academic staff, that takes into account their personal growth as a balance between professional work and personal life has not been an area of scientific interests. The existing research focus mainly on talent management in higher education institutions (e.g. Bradley, 2016; Kamal, Lukman, 2017, in Poland only Pikuła, 2024), but personal development and management thereof is absent in the scientific discourse. The study and implementations described in this article can be considered innovative as they are the first ones to fill this gap.

Thus, it can be concluded that psychological costs incurred by university teachers, which lead to irreversible and serious consequences for both, their health and functioning, and the university, are an important problem which needs to be further explored. If the research and didactic staff members are responsible for the advancement of science (certain disciplines) and the development of students ad other employees, they themselves should be satisfied with their lives and work and experience personal growth that guarantees work-life balance and prevents occupational exhaustion and burnout. Therefore, innovations introduced in one of the universities in southern Poland may inspire management departments of other universities to focus on the development of their employees and organization. Initiatives for the development of academic staff present an interesting set of prevention activities. Thanks to them, fewer employees can struggle with the destructive costs of their work, such as burnout, absence, reduced scientific and research activity. A university which supports personal development of its employees has more chance to receive high evaluation grades of its scientific and research activities, obtain more financial resources for its scientific development and, first and foremost, have satisfied academic team members oriented on self-growth and the development of the university. According to Maslach, Leiter (2010, 2011), good burnout prevention strategies focus on eliminating the sources of occupational burnout which is caused by the mismatch of employees and organization they work in. Therefore, being aware of the costs incurred by the research and didactic staff and the importance of their mental health for the institution, the university management should implement preventive programs.

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PLANNING IMPROVEMENTS BASED ON AGILE REQUIREMENTS ANALYSIS FOR SOFTWARE PROJECTS WITH UNCERTAIN REQUIREMENTS

Ewa MARCHWICKA[1*], Tomasz CYBULSKI[2]

[1] Wroclaw University of Science and Technology; ewa.marchwicka@pwr.edu.pl,
ORCID: 0000-0001-6097-784X
[2] tomcyb27@gmail.com
* Correspondence author

Purpose: The objectives of the paper are to identify agile software projects with uncertain requirements that require planning adjustments and to suggest planning improvements that can be applicable in similar project contexts.
Design/methodology/approach: Semi-structured interviews, literature review and documentation analysis were used as research methods. 509 different IT projects of software outsourcing companies were analyzed in the terms of exceeding estimated time.
Findings: As a result, one project type has been indicated as underestimated. A planning approach incorporating user story prioritization, based on the Kano model has been suggested. Prioritizing project tasks if often used in Agile context, but prioritization process is usually very subjective and performed only by one person (Product Owner). The approach presented in this paper suggests to extend prioritizing techniques to all parties that might be interested (like team members or stakeholders) by collecting questionnaire answers. The process can be done iteratively, which is characteristic for Agile.
Research limitations/implications: The limitation is the superficial analysis of the quality of the approach. Only a general scheme has been presented. Performing detailed quality analysis is planned as future research.
Practical implications: Improving standard prioritization techniques should be valuable for Agile practitioners, because it means better planning. In particular it helps to quicker develop a Minimal Viable Product (MVP) and achieve users' satisfaction. The research indicates one particular Agile project type, for which this approach should be helpful.
Originality/value: According to the literature review research performed by the authors, this paper fills in the gap in the literature of mid-term planning in Agile context.
Keywords: project planning, Agile approach, Kano model, prioritization.
Category of the paper: research paper.

1. Introduction

The dynamic growth in demand for software and the in-creasing digitization of society are having a significant impact on organizations involved in IT projects. The rapidly changing business environment is driving more and more companies to adopt Agile approaches in project management to increase their flexibility and enhance their competitiveness in the market. Classical project management methodologies (also referred to as waterfall) assume fixed project scope that is the input of long-term planning, which tries to answer how long it would take to implement the given set of requirements. On the other hand, Agile methodologies promote adapting project scope to a fixed timeframe of one Sprint (Kosztyan et al., 2020). But this short-term Agile planning cannot guarantee the success of some outsourcing projects (Krancher, 2020). Outsourcing IT projects means hiring an external vendor to handle IT tasks or entire projects, leveraging their expertise and reducing costs (Nicolas et al., 2018).

This study focuses on projects with uncertain requirements, realized by outsourcing companies for which planning improvements are needed. The objective of this paper is twofold. The first objective is to identify outsourcing company project types that need planning improvements and the second one is to suggest and discuss potential planning improvements. What is more, a sample method based on Kano model is presented that allows to incorporate the discussed improvements. The method development is not the objective of this paper, but it has been presented to demonstrate how easy is to apply the improvements.

The Software Extension to the PMBOK® Guide defines software projects as endeavors that involve creating new software products, modifying existing software, integrating multiple software components, expanding software capabilities, or modifying software infrastructure within an organization. Furthermore, software projects can be initiated to address service requests, meet software maintenance needs, or provide operational support. These activities are considered projects if they are defined as temporary undertakings aimed at delivering specific outcomes (PMI, 2013).

The article is structured as follows: Section 2 presents a literature review, Section 3 describes the research methods used to achieve the objectives of the study, Section 4 presents the obtained results, including the identification of issues in IT project planning and an analysis of the underlying causes of these problems. Section 5 discusses potential improvements aimed at addressing these issues. Finally, Section 6 summarizes the conclusion of the study.

2. Literature review

Below a literature review in the areas related to the topic of this articles are presented. The related areas are IT-project planning, effort estimation techniques, prioritization techniques, Kano model and IT project planning.

2.1. IT-Project planning

When using Agile approach, only minimal planning is promoted (Fernandez-Diego et al., 2020). Simultaneously, in Agile approach only Sprint planning horizon is usually considered, and mid-term planning seems to be neglected in the literature. But mid-term planning can still be an important topic in many IT projects (Kosztyan, 2022; Kosztyan et al., 2023), also including the Agile ones or in the projects that use hybrid approach (Kosztyan et al., 2020).

2.2. Effort estimation techniques

No matter in which context (Agile, hybrid or classic) project planning is considered and no matter what planning horizon is the focus of the research (short term or mid-term), effort estimation techniques (Fernandez-Diego, 2020) are required and very important in all project planning applications and methods. The following estimation techniques can be listed: planning poker, expert judgement, wideband Delphi, machine learning, neural network, functional size measurement, regression, algorithmic methods, fuzzy logic, swarm intelligence, Bayesian network, Monte Carlo, Statistical combination, Principal Component Analysis, COCO-MO II, use case point, change effort prediction, ontology model, experience factory, stories prioritization. It should be noted that uncertainty is a common characteristic of estimation (because of many factors, including risks that may materialize during project execution). To handle un-certainty, it is a common practice (Shirazi et al., 2017) and common Agile practice (Cao et al., 2010), to make scope changes as the project progress-es. In Agile it is the time not the scope that should be fixed (Kosztyan, 2020). Scope changes may include adjusting the scope of single user stories, but it can also mean changes made on the project level, when some of the non-important user stories need to be excluded from the scope (Kosztyan, 2020). This is when prioritization techniques come into play.

2.3. Prioritization techniques

Requirements techniques are very popular in Agile planning context (Kosztyan et al., 2020; Kosztyan, 2022; Kosztyan et al., 2023), including the context of global software development (Ali, Lai, 2021). Some popular examples of prioritization include Must-Should-Could-Would Technique (MoSCoW), Analytic Hierarchy Process (AHP), Binary-Search Tree (BST), Voting Techniques and Kano model (Saher et al., 2018).

2.4. Kano model and IT project planning

Kano model is a popular model for assessing the quality of products and services and it appears most frequently in the context of quality (Vavpotic et al., 2019; Golrizgasthi et al., 2019). What is more, Kano model is often cited in reference to product development (Francisco, SantAnna, 2019; Li, Zhang, 2021) and requirements engineering (Campese, Hornos da Costa, 2019). What was already mentioned above, there are Kano model applications to requirements prioritization (Saher et al., 2018). Some other literature positions include applications to minimal viable product development (Lee, Geum, 2021).

No literature positions were found that incorporate Kano model for IT project planning. To the best knowledge of authors this paper is the first one that discusses Kano model in the context of IT project planning. Of course, there is an indirect reference from Kano to IT project planning as Kano is listed as one of the prioritization techniques used for Agile planning (which was described above), but this paper presents an original approach for Kano model representation and incorporates an original and dedicated questionnaire for assessing Kano model quality categories. Additionally, no literature positions were found that consider Kano model in the context of long-term Agile planning.

3. Methods

3.1. Research methods

The research methods used to achieve the objectives of this study included analyzing documentation related to historical data from completed IT projects of outsourcing companies and conducting semi-structured interviews with project managers of the analyzed projects. Another research method that was used was literature reviews.

3.2. Research design

The documentation was used in the problematic projects' identification process. Semi-structured interviews combined with the documentation analysis were used in the analysis of the problem causes. The results of this analysis, combined with literature reviews were used for developing potential planning improvements.

The research design utilized in this work has been visualized in Figure 1.

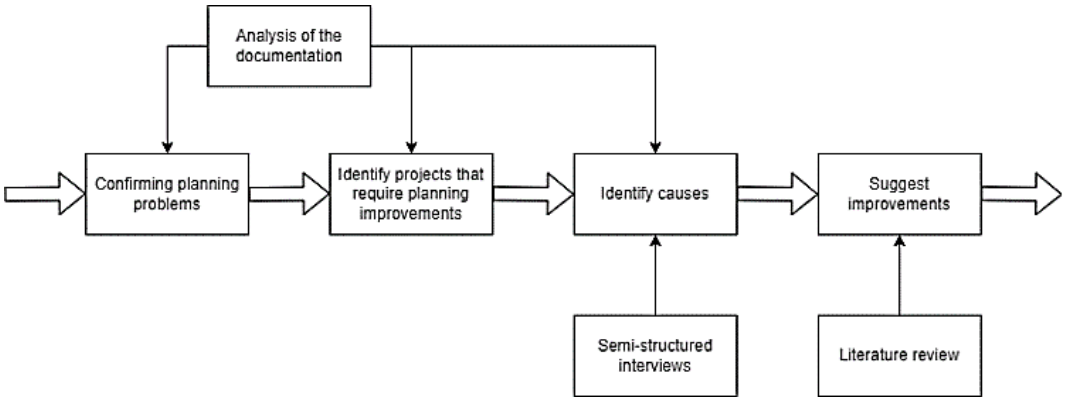

Figure 1. Research design.

The results of the first three steps will be described in the Section 4.

3.3. Data collection

A total of 509 IT projects of outsourcing companies were collected, analyzed and categorized into different types, based on requirement types. The classification presented in this paper not a standard one that can be found in the literature and has been extracted from the available projects' documentation. This classification reveals the wide spectrum of IT projects that can be realized in outsourcing companies. There are many other classifications that can be suggested here but are not considered. For example (Ghodeswar, Vaidyanathan, 2008) presents a classification that is based on business processed. Figure 2 illustrates the distribution of the number of completed projects by project type.

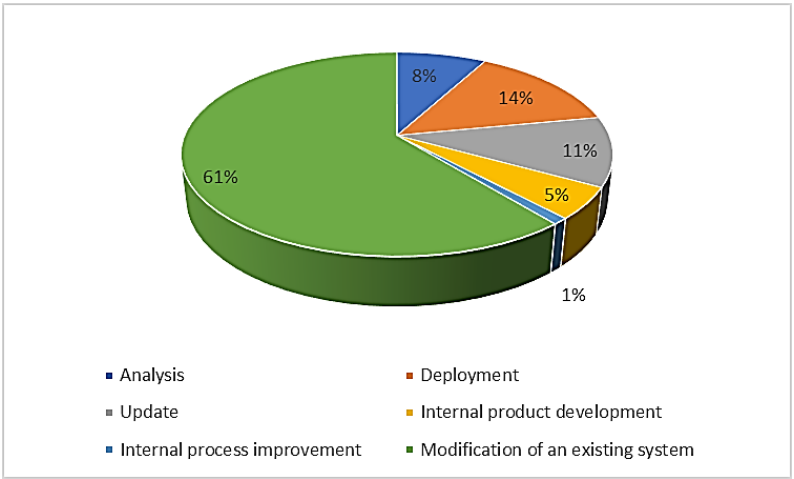

Figure 2. Research design.

Projects of the "Analysis" type aim to gather the business requirements of the client. The end result of projects in this category is the development of a functional specification. For new clients, the analysis is conducted with the purpose of later implementing the system at the client's location. The "Modification of an existing system" projects is connected either with modification of the existing system configuration or client-oriented product development. Another type of project is "Internal process improvement". These projects implement enhancements to the internal company processes, including automation of parts or the entire

process, and the implementation of new tools to facilitate customer support or collaboration between teams. "Internal product development" projects aim to deliver additional functionality in the offered product based on common industry-specific customer requirements. The goal of internal product development projects is to increase future sales by meeting the shared demands of potential clients and retaining existing clients. "Update" projects are intended to implement system updates for a specific client. On the other hand, "Deployment" projects aim to carry out the implementation of the production system for the client. They are preceded by prior analysis.

The dataset contained projects realized in outsourcing companies for different industries. The industries included: automotive, customer services, logistics, energy sector and public sector.

Although in the great number of projects Agile methodologies were declared to be used, more than 90% of the projects were fixed-price projects, where costs (and also the time) were defined in project contract. It means that these kinds of projects required prior time estimations before they could be started, which is the characteristic of waterfall approach. It also means that project estimations data were available for the projects that were analyzed.

4. Results

4.1. Confirming planning problems

To confirm problems in the area of IT project planning in outsourcing companies and later analyzing their potential causes, the preliminary stage involves confirming that planning problems indeed occur. It is realized by analyzing data related to the difference between estimated and actual project durations. These data are visualized using a histogram. The histogram bins are assigned with a granularity of 20%. The results are presented in Figure 3.

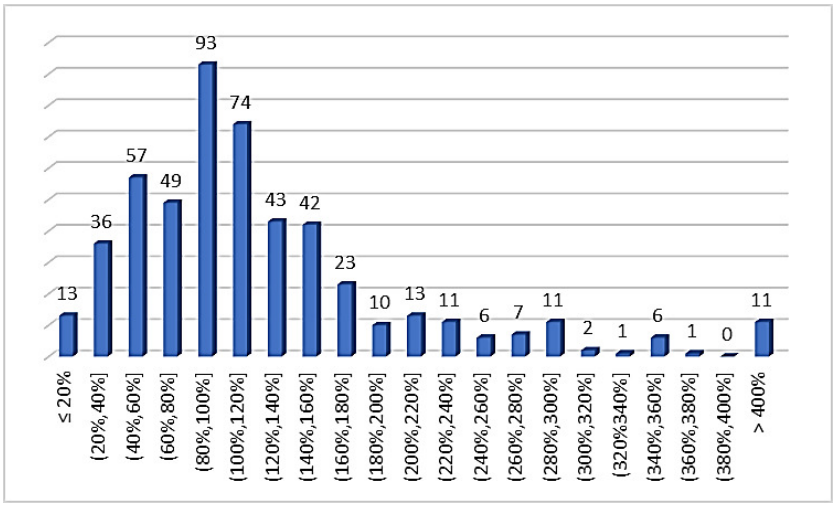

Figure 3. All projects – histogram depicting differences between real and estimated duration.

The obtained results indicate that the actual durations are consistent with the estimates for the largest group of projects, with a deviation of up to +/-20% of the total project duration considered an acceptable margin (two bins that are placed around the reference value of 100%). However, this group represents only 33% of all completed projects. The remaining projects were either underestimated or overestimated. The detailed distribution is presented in Figure 4.

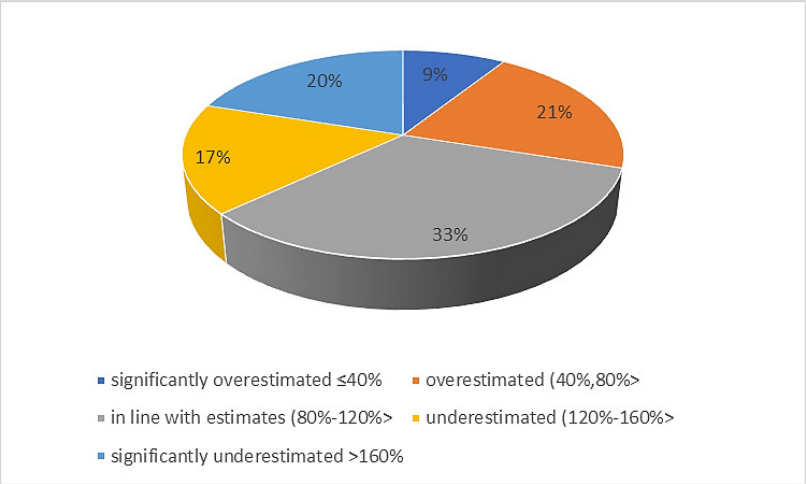

Figure 4. All projects – distribution of overestimated and underestimated projects.

4.2. Identifying project types that need planning improvements

To identify project types that need planning improvements, the standard deviation of the estimated project durations is calculated for each type of project undertaken. The results of the comparison are presented in Table 1. Based on these results, two types of projects were identified with the largest deviations between the actual project durations and the initially estimated durations – internal process improvement projects and internal product development projects. Since internal process improvement projects accounted for approximately 1% of all projects analyzed (Figure 2), the focus is on further analyzing internal product development projects. The presented data suggests that internal process improvement projects are not given the appropriate planning, which can negatively impact their chances of success and achieving their intended objectives.

Table 1.
Basic characteristics of differences between real and estimated durations grouped by project type

Project type	Actual average duration of the project as a percentage of the initial estimated time	Standard deviation
Analysis	105%	0,61
Modification of an existing system	116%	0,88
Deployment	144%	0,96
Internal process improvement	28%	0,13
Internal product development	230%	4,19
Update	166%	1,84
Final average	130%	1,41

The data indicates that the actual duration of internal product development projects averaged at 230% of the initially estimated duration and exhibited the highest variability among all types of projects undertaken. Figure 5 illustrates a histogram depicting the distribution of differences between the actual and initially estimated project durations for internal product development projects.

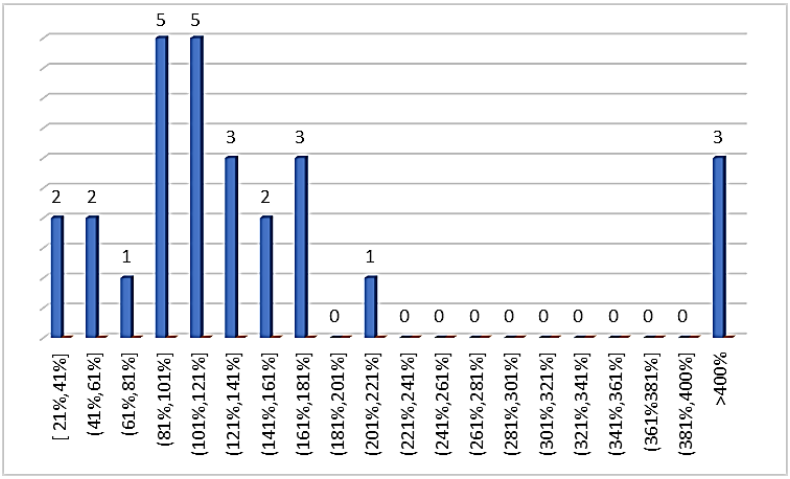

Figure 5. Internal product development projects – histogram depicting differences between real and estimated duration.

Next, the differences for this type of projects are divided into groups and presented in Figure 6.

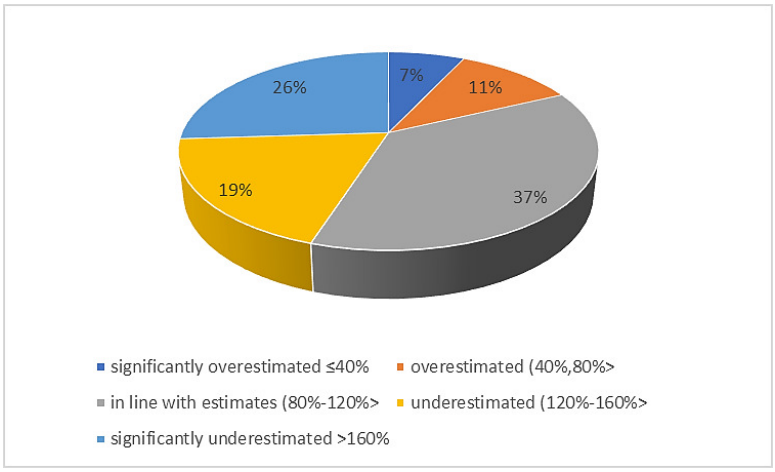

Figure 6. Internal product development projects - distribution of overestimated and underestimated projects.

When comparing the distribution of actual project durations for internal product development projects to the distribution for all projects, it should be noted that despite a higher percentage of projects completed in line with initial estimates, the percentage of highly underestimated projects has increased (red color, Figure 6). Based on the above analysis, a planning problem has been identified for internal product development projects.

4.3. Analysis of the causes of the problem in project planning area

The identified problem was further analyzed to determine its causes. For this purpose, the documentation of selected completed projects was reviewed in detail, and semi-structured interviews were conducted with project managers. Based on this, the causes related to the problem were identified.

One of the causes of the problem that was frequently indicated by project managers is the variability of requirements during project execution. This is an inherent challenge in IT projects because early requirement analysis cannot fully determine the software users' needs.

In the case of internally developed product development projects, the planning phase involves collecting and analyzing requirements, which are then used for implementing novel functionalities by the programming team. Implemented functionalities are then presented to internal stake-holders who verify the produced software. At this stage, overlooked requirements and defects can be identified, or requirement coverage by implemented functionality can be validated. Since such projects are executed internally (which is in fact not typical for the outsourcing companies), the project duration is mainly constrained by internal decisions within the organizations, creating a tendency to include a large number of new requirements extending the project scope and causing scope creep. It should be noted that in this case, the software is not evaluated by external users, suggesting that some internally identified requirements may not provide business value.

It is also worth noting that each implemented software functionality in the project aims to meet the needs of users defined during the requirements analysis. In the examined internally developed product development projects, it is often mentioned that user requirements are determined based on interviews with software users and their own industry experience.

The problem of ad-hoc determination of the functionalities priorities mentioned above results in lower-priority requirements being implemented earlier than those associated with higher-priority requirements, even though they may have lower business value. As a result, the project duration is extended because most of the necessary functionalities are implemented in a later order.

In the literature there exist some formal methods that can be used to prioritize requirements in projects, for example MoSCoW method, which is a technique used to determine the priority of requirements based on stakeholders' positions. Other popular examples incorporate AHP, BST, voting techniques or Kano model (Saher et al., 2018).

5. Discussion

Based on the conducted analysis that ended up with identified causes for the planning problems and supported by the literature review (Figure 1), some selected planning improvements can be proposed. When developing these improvements, the focus was on general solutions that can be applied in any organization carrying out IT projects. Additionally, the proposed improvements were assumed to be simple and easy to implement as part of existing software development processes. The improvements needed to address the main problems described above, i.e. they need to address requirements uncertainty and need to incorporate the process of selecting user story priorities that includes business value.

5.1. Improvements regarding reducing requirement uncertainty

The problem of requirement uncertainty is a well-known issue in IT projects. In the literature, requirement volatility in a project is often described as an almost inevitable part of IT projects, and it is also reflected in one of the principles mentioned in the Agile Manifesto: "Welcome changing requirements, even late in development" (Beck et al., 2023). The causes of requirement volatility can be identified already during the requirement gathering stage. Communication problems may arise when gathering information about requirements from clients or potential system users by business analysts, as well as during the transfer of requirements to the implementation team, leading to misinterpretation of the conveyed information by one of the parties. Presenting requirements in the form of extensive documentation also does not solve the problem because the recipient may lose important elements related to the requirements amidst the overload of details. Furthermore, each party may rely on existing knowledge that may not be relevant to the current situation. Additionally, some knowledge within organizations may not be formalized, making it difficult to codify requirements derived solely from the context and culture of the organization. Another cause is the temporary nature of requirements described in requirement documents. They only address the requirements specified at the time of document development. If the document is not regularly updated during software implementation, the resulting software will not incorporate requirement changes that occurred between their collection and the delivery of the software. Another factor contributing to requirement volatility is the prior experience of potential software users. If the existing software is being replaced, it is often due to a lack of expected features. Therefore, users expect the new system to include previous features as well as new features that were not available in the previously used software. This leads to the constant expansion of the requirement list throughout the implementation of the new software (Kelly, 2024). To minimize requirement uncertainty, an iterative process is proposed, that allows to update the plan, after development team gains more knowledge about the requirements. It leads to the conclusions that the standard Sprint-based approach can be applied, which is not a great

discovery. But it is important is that this iterative approach can be applied not only to the set of requirements that are planned to be implemented in the current Sprint, but to all the requirements available for the project. On the other hand, when time needed for delivering new functionalities is long (which corresponds to the waterfall approach), it is difficult to obtain feedback from end users regarding the usefulness of the introduced changes. Therefore, internal product development projects should be aligned with the Sprint release cycle, allowing for the inclusion of previously developed functionalities in the next software release, rather than incorporating all changes only when the project scope has been completed. When requirements are frequently refined and prioritized (which will be described in the following subsection), it is easier to stop product development or re-negotiate the cost with the client, after project exceeds too much the time that was initially agreed with the client. This perfectly fits in the outsourcing company scenario for the fixed-price project that was described in the Introduction section. The above observations led to the following recommendations that should be considered for an internal product development project:

1. Developing a minimum viable product (MVP) should be the objective of the project from its very beginning. A minimum viable product refers to a product or its part that has a minimal set of functionalities providing value to the end user. Focusing on delivering the MVP helps avoid pro-longed and ultimately unnecessary work.
2. Additional effort of automating manual testing tasks should be considered in project planning, which pays off in later development phases when releasing subsequent software versions. Other repetitive manual tasks should also be automated. This can include automated testing and practices such as continuous integration and continuous delivery. This also seems to be obvious, but it is easy to be forgotten when planning internal product development projects with a fixed price model, considering that the client can refuse the plan, when the forecasted time horizon becomes too long or may sign a contract with a competition in such a case.

5.2. Improvements regarding prioritizing software features

The literature suggests that one of the reasons for failures in traditional project planning are the requirements (and requirements risks) that are not handled correctly (Krancher, 2020). In particular, the prioritization of requirements that is based on the value it brings to users and clients is very important (Saher et al., 2018). The assumption in traditional planning is that all identified work will be completed (Kosztyan et al., 2020), which means that work is performed in the most favorable order from the perspective of the implementation team. Therefore, towards the end of the project, if not all features have been implemented, some of them are abandoned. Because the implementation was not carried out in the order of the most valuable business features, some features with higher value than those delivered are left out (Cohn, 2006).

To improve the process of prioritizing features to be implemented, the use of the Kano model has been proposed, and a complete novel procedure for prioritizing based on this model has been developed. Despite the extensive description of the Kano model in the literature, there is a lack of a comprehensive procedure that incorporates the Kano model in software release planning, taking into account all steps from requirement gathering to priority determination for software features.

To enhance the process of prioritizing software features to be implemented within the scope of internal IT project planning, the following proprietary procedure utilizing the Kano model has been developed. The procedure consists of five steps as presented in Figure 7.

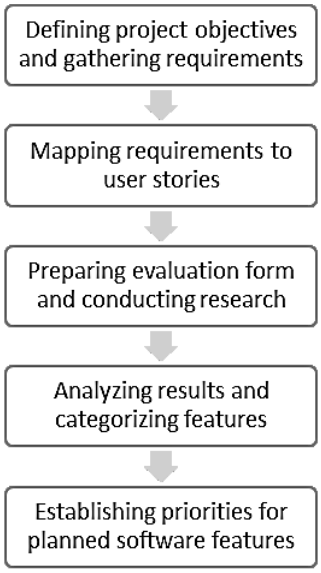

Figure 7. New procedure for internal product development project planning.

To illustrate the practical application of the developed prioritization procedure, the implementation of each step of the procedure is described in detail below:

1. Defining the project goal and gathering requirements. Prior to project planning, the organization establishes a high-level vision and product roadmap. At this stage, the product manager is responsible for preparing the initial project goal and, consequently, the product developed within the project. Before starting to gather requirements and analyzing stakeholders, the product manager should determine the strategic reason for developing the product according to the product manager's assumptions. To achieve this, the product manager should analyze current opportunities and threats, ideally based on both historical and current data. SWOT analysis can be a helpful method (Benzaghta et al., 2012). Based on this analysis, the product manager, together with the forming project team, can justify why the proposed product vision is the right direction for development. The next step is gathering requirements, which enables the preparation of a formal requirements specification. To do this, it is recommended to use techniques such as brainstorming, documentation analysis, interface analysis, focus groups, interviews, observations, prototyping, reverse engineering, or questionnaires (Young, 2002; Maguire, Bevan, 2002).

2. Mapping requirements to user stories. The identified requirements should be presented in the form of user stories. Expressing needs in this format facilitates understanding of the planned software features that will address the discovered user requirements. It is important to ensure that the user stories are at an appropriate level of generality, detailed enough to understand the expected functionality but without unnecessary details that overshadow the overall vision of the software features. To accomplish this, a hierarchical approach can be used. For example, identified general requirements are listed in the top of the hierarchy. Then, for each requirement, the user activity related to the software is described. In the final step, for each user activity, low-level details should be specified in the form of a user story. The user story template "As a <user>, I want <need>, so that <goal to achieve>" can be used for this purpose. Similar hierarchical approach, together with similar user story template is presented in (Wautelet et al., 2014) but requirements are called functionalities there. An example table illustrating mapping of requirements to user stories is presented in Figure 8.

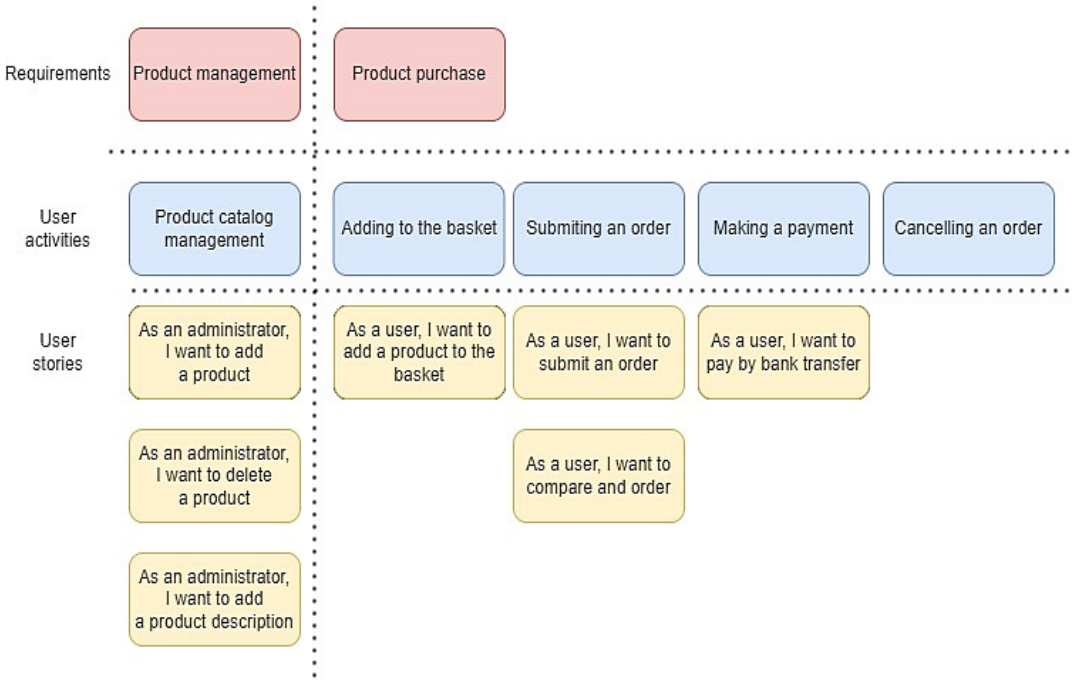

Figure 8. Illustrative example of mapping requirements to user stories.

3. Preparation of the Kano evaluation form and conducting attractiveness assessment. For each defined user story (NOTE: the subsequent text refers to user stories, although they are not in a standard form of a user story template) a Kano evaluation form can be developed to assess the attractiveness of the planned user stories among its potential users. The evaluation form suggested in this paper consists of a list of functional (i.e., "How would you assess the software if the user story is implemented") and dysfunctional questions (i.e., "How would you assess the software if the user story is NOT implemented") for each examined user story. The template of the evaluation form is presented in Table 2.

Table 2.
User stories evaluation form template

How would you rate the product if:	Like it very much	Like it	Neutral	Don't like it	Don't like it very much
Satisfaction	**2**	**1**	**0**	**-1**	**-2**
1a. you could …					
1b. you couldn't …					
2a. you could …					
2b. you couldn't …					
…	…	…	…	…	…

The Kano model suggests five possible quality categories for the products and services, that are based on the customer satisfaction level and the degree to which the product or service can be delivered (Aslamiyah, 2023). These categories are: Must-be (here referred to as MB), One-dimensional (here: 1D), Attractive (here: AT), Reverse (here: RV) and Indifferent (here: IN). These categories are usually depicted in two listed dimensions of satisfaction level and a degree of implementation. MB category means that when this product or service is implemented, customers are neutral but are not satisfied when it is not implemented. 1D category means that customers are satisfied when the product or service is implemented and dissatisfied when not. AT means satisfaction when product/service is achieved fully, but it does not cause dissatisfaction when it is not implemented. RV means high level of dissatisfaction when implemented and IN is reserved for product/services that neither cause satisfaction nor dissatisfaction and are indifferent for the customer. In this paper we suggest a different representation of the Kano model that is adjusted to the construction of the questionnaire that was proposed: the dimensions are five possible levels of satisfaction when user story is implemented (-2, -1, 0, 1, 2) and five levels of satisfaction when user story is not implemented (-2, -1, 0, 1, 2). This leads to the model presented in the following figure, where MB = <0,-2>, 1D = <2,-2>, AT = <2,0>, IN = <0,0> and RV =<-2,0> (Figure 9).

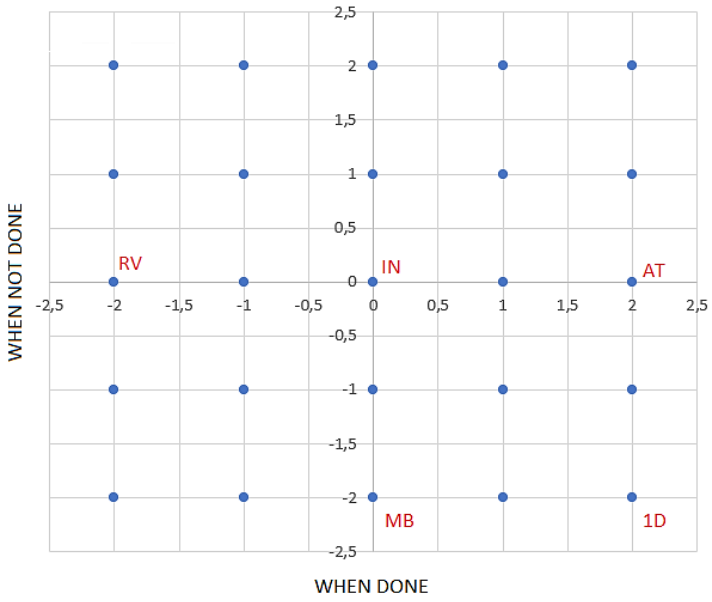

Figure 9. Kano model representation adjusted to the suggested evaluation form.

Having a questionnaire, it is necessary to select a research group and conduct the survey. To obtain reliable research results, the research group should consist of an adequate number of respondents representing different groups of potential users.

To verify the credibility of the obtained responses, a so-called lie scale (Stupnicki, 2015) can be included in the questionnaire. For this purpose, the same software feature questions should be repeated in the response sheet using different formulations and placed in different sections of the form. Then, a reliability criterion should be established, for example, the agreement of 4 out of 5 pairs of questions forming the lie scale. If there is only one pair with inconsistent responses, the survey is considered reliable. If two or more pairs have inconsistent responses, the survey of that particular respondent should be disqualified. An example of a completed form is presented in Table 3.

Table 3.
An example of a completed form

How would you rate the product if:	Like it very much	Like it	Neutral	Don't like it	Don't like it very much
Satisfaction	**2**	**1**	**0**	**-1**	**-2**
1a. you could display an analysis of the history	X				
1b. you couldn't display an analysis of the history					X
2a. you could undo the last operation		X			
2b. you couldn't undo the last operation					X
3a. you could add a profile photo	X				
3b. you couldn't add a profile photo			X		

4. Developing survey results and assigning categories to user stories. Based on the obtained results from the previous step, each user story U should be assigned to a category of the Kano model ({MB, 1D, AT, IN, RV}). To perform this assignment, for each user story U that is considered, all functional responses and all dysfunctional responses are summed (possible responses are integer values from the set of possible values {-2,-1,0,1,2}), and the average response is calculated as $U_f = \sum_{i=1,\dots,N} U_f^i$, for the functional responses and $U_{df} = \sum_{i=1,\dots,N} U_{df}^i$ for dysfunctional responses, where N is the number of responses collected. Then a pair $<U_f, U_{df}>$ is determined and a nearest Kano representative of a given category (see Fig. 9) is determined. Obtaining similar distances for more than one Kano representatives may indicate the presence of subgroups within the research group that perceive the user story differently. In such a case, the responses should be reanalyzed by splitting the research group into sub-groups. Also obtaining big spread of the questionnaire answers (e.g. standard deviation that is greater than a given threshold) may indicate similar problem.

An example result of assigning user stories to categories of the Kano model is presented in Table 4.

Table 4.
An example of assigning user stories to the categories of the Kano model

User story	Distance to MB	Distance to 1D	Distance to AT	Distance to IN	Distance to RV
Displaying an analysis of the history	1,58	0,70	1,58	2,12	3,81
Undoing the last operation	0,5	2,06	2,5	1,5	2,5
Adding profile photo	1,41	1,41	1,41	1,41	3,16

For the first functionality, "Displaying historical analysis", the shortest distance to category representatives indicates that it is a one-dimensional (1D) user story. This suggests that this function linearly affects the satisfaction of the end user – the more extensive it is, the more positively it will impact user satisfaction. For the functionality of "Undoing the last operation", the closest representative is the must-be (MB) category. This indicates that this user story must be implemented, otherwise it will significantly decrease the satisfaction of the end user. In the case of the last user story, "Adding a profile picture", the responses indicate that it can belong to all: MB, 1D, AT or ID categories (as distance to all of them is similar). This suggests that there may be subgroups within the surveyed group that perceive this function differently.

5. Determining the priorities of the planned software functionalities. Based on the categories assigned to the user stories, each user story should be given a priority. User stories with low priority should be excluded from the project scope first if there are insufficient resources to implement them. When assigning priorities and following the Kano model, the following observations can be done:
   - Must-be user stories must be implemented before software release.
   - One-dimensional user stories should be included as much as possible, but some of them can be abandoned if it is not feasible to implement all of them.
   - Attractive user stories should be implemented at least in a small number, as they result in a significant increase in user satisfaction when present in the product.
   - Indifferent and reverse user stories should be abandoned as they do not bring value to the user or negatively affect their satisfaction.
   - Questionable user stories can be reanalyzed in another research group. If conflicting results continue to be obtained, they should be reformulated or abandoned.

According to the improvements suggested in the previous subsection, the presented procedure (excluding its first step) should be performed in every Sprint. It then allows tracking the progress of the MVP version comparing to the initial time estimations of the product development.

5.3. Validation procedure

In order to measure the quality of the proposed method, a survey of software usability evaluation among its users can be conducted after the release of the MVP version, in the planning of which the proposed procedure was used. Based on the obtained results, it is possible to assess whether the new version of the software meets the needs of users to the expected extent. These results can then be compared with the results prior to the improvements described in this article. The described procedure should be supplemented with a procedure for evaluating the quality of planning. By measuring the difference between the estimated and actual MVP release time and expressing it as a percentage of the estimated value (as was done in the planning problem identification presented at the beginning of this paper), a simple assessment of planning quality can be obtained. Both above procedures are suggestions only. Collecting the results from these procedures will be the subject of further research.

The advantages of the proposed procedure include the previously mentioned simplicity and the ability to be implemented as part of an existing software development process. Among the disadvantages of the proposed procedure, issues with verifying the reliability of results obtained from respondents' answers and a lack of systematic procedure for determining final priorities can be highlighted. The first issue can be minimized by using the previously described lie scale. The second issue is the limitation of the current method, which was only a suggestion, and its development was not the main objective of this article. Anyway, this systematization is planned as part of further research. The advantages and disadvantages of the proposed procedure, are summarized in Table 5.

Table 5.
Advantages and disadvantages of the proposed procedure

Advantages	Disadvantages
- Simplicity of the procedure - Ability to implement the procedure as part of an existing agile software development process	- Difficult to verify the credibility of the survey results - Lack of a systematic procedure for determining the final priorities of user stories, based on the described Kano forms

6. Summary

The application of the Kano model in Agile context is already present in the literature (Saher et al., 2018) but the contribution of this paper is the analysis that was performed that helps to determine project types (based on project requirements criteria) for which it is best to use the Kano model. Project classification suggested in this article has not been described in the literature. What is more, the author’s method of collecting inputs for the Kano model, that is based on the questionnaire, is original and novel and has not been presented in the literature so far. Another contribution of the paper is that the Kano model is applied to project planning,

which, according to the authors' literature analysis, has not been described anywhere, at least not in case of mid-term planning that goes beyond the Sprint frame.

Based on the conducted research, it has been found that Agile project management methodologies like requirements prioritization described could help to improve project planning.

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SELECTED PROBLEMS OF INFRASTRUCTURE DEVELOPMENT FOR RESIDENTS OF THE MIDDLE POMERANIAN REGION: CASE STUDY

Marcin OLKIEWICZ[1*], Joanna Alicja DYCZKOWSKA[2]

[1] Koszalin University of Technology; marcin.olkiewicz@tu.koszalin.pl, ORCID: 0000-0001-6181-6829
[2] Koszalin University of Technology; Joanna.dyczkowska@tu.koszalin.pl, ORCID: 0000-0001-9866-3897
* Correspondence author

Purpose: The main purpose of the article is to identify and evaluate the impact of selected infrastructure elements on the development of the Middle Pomeranian region. Efforts were made to prove that infrastructure of appropriate quality is the basic condition for the development of the region.
Design/methodology/approach: In the study, quantitative and comparative methods were used in the data analysis. The article uses a comparative analysis of the road infrastructure of two counties: Koszalin and Slupsk. The analysis was supplemented by a diagnostic survey using a questionnaire survey technique among the inhabitants of both counties.
Findings: In Koszalin, significant changes included: installation of ticket machines and e-tickets (94%), increased availability of city bikes (72%) and scooters (26%), and connection to Mielno by rail bus (56%). In Slupsk, on the other hand: extension of bicycle paths (38%), modifications of some routes for city buses (24%) and improvement of connections with suburban towns (16%).
Research limitations/implications: After the completion of the S6 and S11 developments, a repeat survey should be carried out. According to the authors, these investments affect the quality of life of the residents in the areas studied. Surveys should be carried out on a larger group of respondents, particularly taking into account rural areas.
Practical implications: Investments in the modernisation and development of infrastructure, including road infrastructure, were central to strategic regional development activities. They attracted investors for the development of business and were also a factor in the construction of the logistics center in Koszalin.
Social implications: The development and increase in transport options for residents has directly improved the quality of life for residents. The completed road investments also contribute to improving living conditions and increasing the attractiveness of the region by making it more accessible. The well-developed transport infrastructure of the Middle Pomeranian Region gives specific benefits by increasing the number of tourists.
Originality/value: The analysis of the interaction between transport infrastructure and the economy, as well as the measurement of the satisfaction effect of this interaction, is an important issue in the context of the implementation of the strategic development plan adopted by local governments and the government.
Keywords: development, infrastructure, Middle Pomeranian Region.
Category of the paper: Research paper.

1. Introduction

Development is perceived as an interdisciplinary and very broad meaning (Mitra et al., 2023; Hajian, Kashani, 2021; Payán-Sánchez et al., 2021; Sen, Kumar, 2023). It is also difficult to clearly define development in the area of transport (Guirao, 2021; Wiktorowska-Jasiak, 2016). This may result from the specificity of transport and its types (Oviedo, Nieto-Combariza, 2021; Wiśniewska et al., 2017). The role of transport and (more broadly) logistics infrastructure in economic growth is one of the most frequently discussed topics in recent times. Compared to development expenditures such as education and health, which produce results in a very long time horizon, the progress of investments in infrastructure is physically visible and can bring results in a shorter time. In the field of economics (especially political), it is widely believed that the development of the logistics sector can change the economy in a few years (Guirao, 2021; Chia-Lin2021; Arshed et al., 2022). Road infrastructure is part of the transport infrastructure. It includes elements of the transport network used by means of transport during movement and standstill (Harańczyk, 2015). The road transport infrastructure is divided into linear infrastructure (road network) and point infrastructure (passenger, cargo, means of transport and people services) (Wojciechowski et al., 2009). However, the development of infrastructure to a large extent, if we consider its pace, depends on the number and size of problems, deficiencies, incompatibilities, etc. The linear infrastructure of road transport can be classified according to the criterion of the function performed and the following roads are distinguished: national, voivodship, poviat, commune, company, local and municipal roads. Such a correlation may occur, for example, between regional development and the condition of road infrastructure or public transport (Guirao, 2021; Oviedo, Nieto-Combariza, 2021; Vulevic, 2018). Therefore, an important element of development is improvement. Transport logistics infrastructure is defined as a complex of interconnected elements ensuring material flows. Its key functions include, among others, improving the regional level of socio-economic development (thanks to the efficient functioning of various types of transport and building a sustainable transport network), meeting the needs of economic entities for transport facilities (including logistics), or improving the functioning of the storage system.

In recent years, the problems of transport logistics require a comprehensive study, namely, a thorough consideration of the processes and objects of transport logistics infrastructure in the context of their interaction as a complex system (Bychkov et al., 2016). The term "infrastructure" comes from the Latin language, namely the word "infra" is understood as foundations or foundations, while "structure" means the arrangement of elements of some undefined configuration. As defined in the Cambridge Advance Learner's Dictionary & Thesaurus (2016), "infrastructure" is basic systems and services such as transport and power, that a country or organization uses to operate effectively. Infrastructure is an element of the territorial structure of the national economy, which consists of transport, communication, trade,

energy and water management, as well as housing (Skorobogatova, Kuzmina-Merlino, 2017). In the case of the development of transport infrastructure, three of the many effects that are of particular importance are mentioned. Among other things, these are direct benefits for users, achieved through the impact of investment projects in road infrastructure on traffic safety. The effects include a smaller number of road accidents, which are not only personal tragedies, but above all financial. For over several decades, in efficient and developed economies, the loss of health or life has been converted into measurable economic and financial losses (lower tax revenues, lower consumption, loss of part of the national income, payment of compensation, costs of treatment and rehabilitation, etc.) (Górczyńska, Krawczyk, 2014). Improvement is one of the significant determinants of pro-development activities, in particular in terms of organizational, material and social conditions, including in the area of transport (Wojewódzka-Król, Załoga, 2016). This may result from the necessity and essence of the implemented changes, in particular to increase the existing transport potential (of the country, individual territorial units) as well as the satisfaction of market stakeholders (Kaczyńska, Korycińska, 2014). Because it is them: entrepreneurs, residents, offices, tourists, etc. who build loyalty, image and also affect the profitability of investments (e.g. road, public transport infrastructure) and transport entities. By increasing the safety of road users, both individual and public, we can influence the individual location decisions of the stakeholders of a given market. Therefore, it should be remembered that by improving the quality of life of the society, as part of the development of infrastructure, we increase the socio-economic and economic opportunities of both local government units in a given region and entities operating there (Olkiewicz, 2020).

The analysis of the literature shows that all transport development activities are carried out according to identified needs (area of aware market needs), action planning and action (method of achieving technical parameters in accordance with the assumptions), compliance control and improvement of previous stages (verification and standardization of the effect achieved) form a comprehensive whole (Gibbons et al., 2019; Meijer et al., 2018). Therefore, they cover the areas of strategic management (e.g. creating long-term development of road infrastructure), operational management (e.g. efficiency and optimization of executive processes), organizational (e.g. making activities related to issuing permits, tender procedures, etc.) more flexible, resources (e.g. financial), safety (e.g. in environmental protection aspects), quality (e.g. performance of individual elements of infrastructure (technology and raw material applications), projects (e.g. implementation of innovation or creating cooperation between various research and development centers, etc.), and others (Persia et al., 2016; Qi et al., 2020; Reshetnikova et al., 2021). It also indicates the complexity of identifying factors determining the development of transport. Each of the above-mentioned areas of management, or its components, may have a greater or lesser impact on the implementation of changes in transport.

Global threats to the development of the transport system (passenger and freight) resulting, among others, from transport congestion, climate change, negative impact on the natural environment and living conditions of society, make it necessary to apply a sustainable transport

policy. According to the OECD, the transport policy should be based on the principles of: access to transport services while maintaining the requirements of health and environmental safety; reducing the negative impact on the environment; economic efficiency or intergenerational justice (OECD, 2004; Farhadi, 2015; Churchill et al., 2021). Meeting such expectations requires a broader perspective on the region's logistics, mobility, access to the infrastructure of "green zones", etc. through the prism of time and investment financing opportunities. It is also in line with the state's transport policy, as it is aimed, among others, at: reducing the nuisance of transport for residents; protection of the natural environment and its non-renewable resources; reduce the risk of accidents; ensuring equality in access to means of transport, or creating appropriate conditions for the functioning of public, freight and individual transport (Kalisiak-Mędelska, 2017; Wolniak et al., 2019). Poland's road infrastructure still requires large expenditures on development and ensuring appropriate standards of the existing network in order to be able to meet the needs of the market resulting from the increase in the exchange of goods and the constantly growing passenger traffic. A well-developed and modern network of motorways, expressways and expressways is a prerequisite for the proper functioning of economically developed countries (regions).

2. Materials and methods

The aim of the study was to show the impact of selected infrastructure elements on the sense of development of the region among the inhabitants. As part of the research, the following hypotheses were put formulated:

- H1 – an increase in expenditure on the modernization and development of infrastructure increases the attractiveness and satisfaction of the inhabitants of a given region.
- H2 – an increase in the number of individual infrastructural linear elements increases the efficiency of communication and improves the quality of life of residents.

The research conducted in December 2022 in the Middle Pomeranian region focused on two main cities (of this region), i.e. Koszalin and Slupsk, making a comparative analysis. Respondents in the amount of 100 people (50 people from each city) took part in the survey in June 2022. In Koszalin, 37 women and 14 men, aged 18-30 (47%), 30-45 (17%) and 56 and over (36%) participated in the study. Due to the specificity of the scope of the study, it was found that as many as 92% of the respondents are professionally active in the surveyed population. In Slupsk, 32 women and 18 men, aged 18-30 (58%), 30-45 (14%) and 56 and over (28%), participated in the study. Due to the specificity of the scope of the study, it was found that as many as 91% of the respondents are professionally active in the surveyed population.

3. Results

Analyses and research in the field of transport development usually begin with the identification and assessment of the condition of road infrastructure. This is due to the fact that it fulfills many different tasks and can contribute to competitiveness and/or improve cohesion between neighboring territorial areas. Figure 1 shows the current condition of road infrastructure as of April 28, 2023. Green color indicates very good or good condition, yellow - average or slightly deteriorated, orange - bad (critical). The blue color indicates roads under repair.

Figure 1. Condition of road infrastructure as of April 28, 2023.

Fig. 1 shows that the quality of roads in the Middle Pomeranian region is not that bad. Of course, there are visible fragments of roads requiring immediate corrective action. Therefore, as part of the measures taken to develop the infrastructure of motorways and expressways, both in Zachodniopomorskie (approx. 20,406 km of roads, including 8% national, 27% municipal, 15% provincial and 50% poviat) and Pomorskie (approx. 22,827 km of roads, including 6% national, 45% communal, 13% voivodship and 36% poviat) activities are carried out that significantly affect the quality of road infrastructure in the Middle Pomeranian region, Poland. The currently implemented activities are presented in Fig. 2.

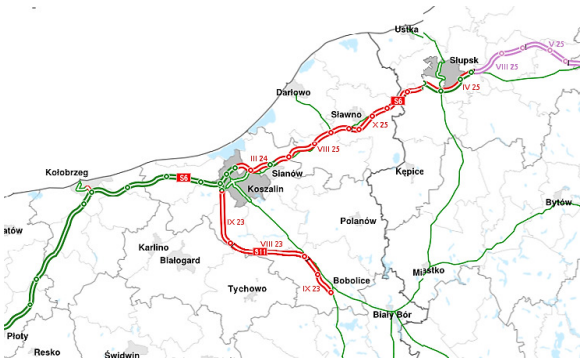

Figure 2. Construction status of highways and expressways.

Figure 2 shows that the main activities are the works carried out on the S6 connecting the Zachodniopomorskie and Pomorskie voivodeships and the S11 being created connecting the Middle Pomeranian region (the area of the Zachodniopomorskie voivodship) with the Wielkopolskie voivodship. A section of the S6 road along the Koszalin bypass and the S11 road from Koszalin to Bobolice, 48 km long, are under construction. The S6 road connecting both voivodships from Koszalin to Lebork, and the S11 road from Bobolice to Szczecinek are in the design phase.

The key element determining the economic development of the Middle Pomeranian Region is undoubtedly the construction of appropriate infrastructure. It should be remembered that it must also be constantly modernized and expanded so as to adapt it to the constantly changing conditions and expectations of market stakeholders. Figure 3 presents data on the % increase in km of roads compared to the base year (2015).

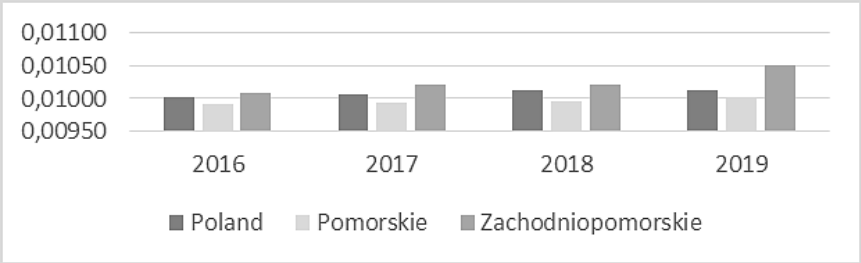

Figure 3. Value of the road increment in [%].

The analysis of Fig. 3 shows increasing trends in all cases. However, the greatest increase is visible in the Zachodniopomorskie voivodeship, in particular in the Middle Pomeranian region. It should also be added that along with the development of road (linear) infrastructure in the Middle Pomeranian region, the number of bridges increased (4 pcs.), 15 road culverts, 4 roundabouts, and embankments along expressways and national roads (e.g. Szczecinska Street in Koszalin). For example, in the city of Koszalin, the implemented urban infrastructure investments required a significant financial contribution from the city, i.e. modernization and construction of roads along with the infrastructure accompanying:

- Str. Mlynska - Kilinskiego square, cost approx. PLN 10 million (of which government funds amount to PLN 1.5 million).
- 2 viaducts (str. Wladysława 4 and Monte Casino) - cost approx. PLN 50 million (24 million government funds).
- reconstruction of str. Franciszkanska 3.5 million (1 million government funds).
- str. Szczecinska (national road 30) 36 million (30 million government funds).

The data indicate that the implementation of infrastructural investments requires significant financial resources. In particular, in own investments, i.e. municipal (municipal), government aid is visible in a small percentage.

Also, along with the development of the identified infrastructure, problems have arisen regarding e.g. with access to real estate (necessity to buy real estate from natural persons), financing of tasks (mobilization of reserves and other sources of financing), traffic difficulties (use of detours or road narrowing), impact on nature (necessity to use culverts, fences, etc.), or the presence of groundwater (S6 – area of the Sianow commune). All the difficulties significantly affected the pace of investment implementation, which directly translated into the quality of life of the residents. At the same time, the infrastructure created in Koszalin increased investment opportunities, i.e.:

- The economic zone was extended by 75.3 ha, creating infrastructure for production facilities, warehouses and warehouses. The permissible development of the building plot area is 65-75% and the minimum area of the investment area is 0.4 ha. The entire area in the period 2020-2023 is developed by m. entities such as: DPD, Romex Koszalin, Bałtyk-Trans-Spedition, James Windows or ASWO.
- The attractiveness of areas for single-family and multi-family housing has been increased.
- By increasing the capacity to the coastal areas, development, commercial and gastronomic activity has increased.
- Expenditures on the development of tourist activities, including agritourism, were increased.

The study of infrastructure and its importance for the inhabitants of the Middle Pomeranian region, in particular from the main cities, should be considered mainly through the prism of the respondents' ability to use public transport. This is important because it directly relates to both the assessment of the quality of services provided and other facilities of the vertical infrastructure. Therefore, the study tried to select a population that uses the existing infrastructure, as shown in Fig. 4.

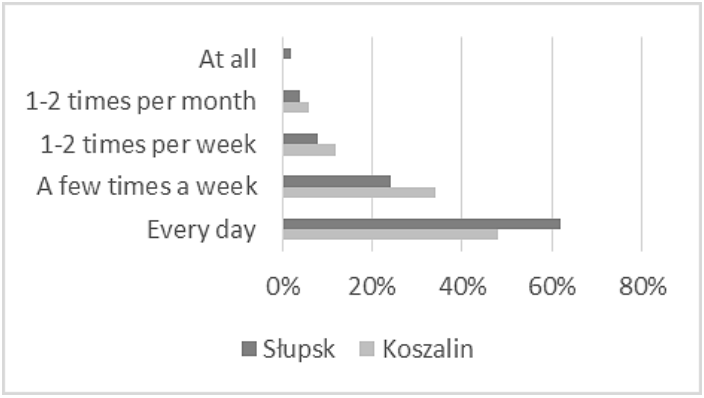

Figure 4. Frequency of use of vertical infrastructure.

The data shows that as many as 62% of respondents from Slupsk, compared to 48% from Koszalin, use the road infrastructure every day. Table 1 shows information on which means of transport are most often used by the respondents.

Table 1.
Preferred public transport

	City bus	Suburban bus	City bike	City scooter	Passenger ship	Railbus
Koszalin	86%	14%	12%	4%	4%	12%
Slupsk	83%	40%	18%	0%	0%	0%

The choice of transport preferences results from various reasons, e.g. lower transport costs, convenient connections (indicated by 65% of respondents from Koszalin, 72% from Slupsk) or the lack of their own means of transport (indicated by 23% of respondents from Koszalin, 18% from Slupsk). The study also showed that, according to the respondents, the communication system is positively assessed, i.e. it is well adapted to the needs of residents (indicated by 46% of respondents from Koszalin, 53% from Slupsk), despite the fact that the frequency of courses was limited (64% of respondents from Koszalin, 66% from Slupsk). However, it should be emphasized that the respondents would expect some changes regarding, among others: increasing the frequency of bus routes (indicated by 94% of respondents from Koszalin, 97% from Slupsk), modification of city bus routes (indicated by 96% of respondents from Koszalin, 98% from Slupsk), or more bicycle routes (indicated by 25% of respondents from Koszalin, 32% from Slupsk). Summing up, the study shows (Fig. 5) that the respondents' assessment of the existing state of infrastructure and the possibility of using public transport is quite negative.

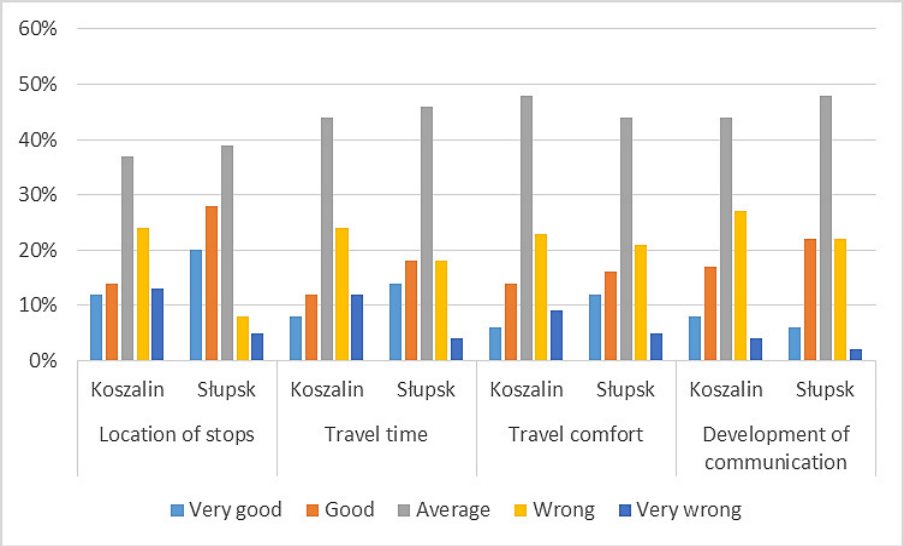

Figure 5. Assessment of selected factors shaping the satisfaction of respondents.

This means that those responsible for planning investments in transport, in particular transport infrastructure, have a lot to do. It should be noted, however, that in the assessment of activities implemented in the period 2019-2022, respondents indicated positive changes. In Koszalin, significant changes included: installation of ticket machines and e-tickets (94%), increased availability of city bikes (72%) and scooters (26%), and connection to Mielno by rail bus (56%). In Slupsk, on the other hand: extension of bicycle paths (38%), modifications of some routes for city buses (24%) and improvement of connections with suburban towns (16%).

4. Conclusions

The plan of road investments in the area of Middle Pomeranian Region for the coming years assumes high investments. It plans to expand national roads, bypasses, motorways and expressways on a large scale. The most important goal of the Program adopted by the Council of Ministers is to shorten the travel time between major Polish cities by at least 15%. It is important that the government allocates funds for this, as well as for the maintenance of existing roads, which is proved by the analysis presented in the article. One of the major problems related to the road infrastructure is the poor condition of the road surface, which is emphasized by the inhabitants of Koszalin and Slupsk, and the related renovation needs. Only half of the national roads managed by the GDDKiA (General Directorate for National Roads and Highways) meet the conditions for classifying them as being in good condition. Renovation of linear infrastructure elements (such as viaducts in Koszalin) may affect not only the quality of movement of the city's inhabitants, but also the entire area of Middle Pomeranian region.

The transport and logistics integration of Middle Pomeranian region is based on the concept of the Northern Transport Corridor and a number of key projects in the development of transport. The transport network that has not been completed should be supplemented as currently S11. It is advisable to perform additional research to determine the role of road infrastructure projects not only for residents and tourists, but also in the area of potential cargo turnover. There is no doubt that countries such as Poland, with greater capacity due to, for example, transit, certainly have a greater impact on economic growth, not only in Middle Pomeranian region, Poland, but also in Europe.

On the other hand, in addition to the socio-economic factors described in this study, it was also shown that improved transport contributed significantly to economic growth. Therefore, the inclusion of these factors in further research could definitely provide a more comprehensive overview of the factors affecting the economic growth of the region, country and Europe.

Changes resulting from the expectations of market stakeholders and socio-economic conditions had a significant impact on the size and pace of development of the infrastructure elements of the Middle Pomeranian Region. All activities carried out by the entities managing this area (the Koszalin City Hall and the Slupsk City Hall) were aimed, among others, at improving the quality of infrastructure and the quality of life of the region's inhabitants. Ensuring efficient transport connections significantly increases the processes of goods exchange between regions and countries, and increased transport needs are connected with the functioning of economies and social (local) life. As part of the conducted research, it was shown that selected elements of the structure have an impact on the development of the region. It was also shown that investments in the modernization and development of infrastructure,

including road infrastructure, were key in the strategic activities of regional development. On the one hand, it attracted investors to the development of entrepreneurship, and on the other hand, communication opportunities increased, which directly improved the quality of life of residents. Also implemented road investments (Fig. 2) contribute to the improvement of living conditions and increase the attractiveness of the region by increasing their accessibility. Transport is a priority development direction for Middle Pomeranian Region. Adequate infrastructure is a basic prerequisite for a national transport system. Transport has a significant direct and indirect impact on economic efficiency and growth, and there is a reciprocal relationship between the quality of transport infrastructure and regional development. The well-developed transport infrastructure of the Middle Pomeranian region gives specific benefits by increasing the number of tourists. Therefore, the analysis of the interaction between transport infrastructure and the economy, as well as the measurement of the satisfaction effect of this interaction, is an important issue in the context of the implementation of the strategic development plan adopted by local governments and the government.

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DRONE SWARMS – AS AN INNOVATIVE TOOL TO CARRY OUT IRREGULAR WARFARE

Marcin OLKIEWICZ[1*], Radosław WOLNIAK[2], Mariusz TEREBECKI[3]

[1] Koszalin University of Technology; marcin.olkiewicz@tu.koszalin.pl, ORCID: 0000-0001-6181-6829
[2] Silesian University of Technology; radoslaw.wolniak@polsl.pl, ORCID: 0000-0003-0317-9811
[3] Pomeranian Academy in Słupsk; mariusz.terebecki@apsl.edu.pl, ORCID: 0000-0002-2455-2067
* Correspondence author

Purpose: The main purpose of the article is to analyze the possibilities of using drone swarms as an innovative battlefield tool.
Design/methodology/approach: The research includes simulation methods by using computer simulation methods based on the so-called random walk – Brownian motion and Brownian bridge.
Findings: The research shows that the innovative use of drone swarms will further increase the possibility of using them in an asymmetrical conflict. Particularly important is the cheapness of the presented solution, the possibility of using it after only a short training and the option to perform an earlier simulation of the effects of the drone swarms application by people with an average level of IT knowledge.
Research limitations/implications: The study focused on analyzing the possibilities of using simulation methods to manage innovative drone swarms exclusively for military purposes and the possibilities of using such solutions. According to the authors, the research should be carried out in other areas of social life.
Practical implications: In the era of Industry 4.0, which is based on digitization and robotization, it will be possible to increasingly use solutions that make use of artificial intelligence (AI) on the battlefield, such as the application of innovative drone swarms.
Originality/value: The presented solution is based on innovations in various areas, it can be stated that this type of drone application is an open innovation and can be developed by both military and civilian companies.
Keywords: open innovation; national security; drones; Industry 4.0; warfare; Brownian motions.
Category of the paper: Research paper.

1. Introduction

Currently, new innovative solutions in military technology are increasingly appearing, the use of which may lead to the improvement of the functioning of an army on the modern

battlefield. One of such modern innovative solutions is the use of drones for military applications (Li et al., 2022; Rozmirez-Montoya et al., 2022). The issue of innovation is important for the development of the contemporary military industry because as a result of the use of innovations, including open innovations, the effectiveness of technical solutions used in the military can be significantly improved (Sloane, 2011; Gajdzik, Wolniak, 2021, 2022; Lee et al., 2018, Bober et al., 2017). Such solutions are in line with the contemporary trends in the implementation of the so-called Industry 4.0 concept, which is based, inter alia, on digitization, robotization and application of artificial intelligence (Olkiewicz et al., 2019; Drozd, Wolniak, 2021). The innovative use of drones presented in this publication is an example of this. In the literature, there are currently three parallel terms related to the subject of drones: (UE, 2019) unmanned aerial vehicle (UAV) (Tice, 2009), unmanned aerial system (UAS) and the most popular – drone. All of these terms refer to an aircraft that does not require a flight crew on board and is not able to board passengers (Fowler, 2014). The aircraft is remotely piloted (guided by a pilot that does not have to see the drone) or performs the flight autonomously (by itself, using the autopilot or other system on-board). In addition, the term unmanned aerial system refers to a system comprising several components. The components include a drone, a control system, a telecommunication link to pilot the drone and the drone's equipment (Aroosa, 2021; Fairehead, 2021).

Soon, wars could be fought without the participation of humans. Intelligent drones will start to appear on the battlefields, and other autonomous machines will join them (Johnson, 2019; Hallaq et al., 2017). Such innovations in the military constitute a revolution on the modern battlefield, changing many aspects of the warfare, especially in the case of asymmetric conflicts, where one of the sides is weaker in terms of conventional military (Bousquet, 2017; Boyle, 2015; Mack, 1975; Jacob, 2017; Yun, Liu, 2019). The issue of asymmetric wars is important because contemporary armed conflicts are usually of this nature (Cianciara, 2021).

The ongoing war in Ukraine and the previous conflicts of recent years have proven that drones are becoming increasingly used equipment on the battlefield (Byman, 2013). They have been an effective weapon against military units armed with Russian equipment in the past. They got a lot of publicity during the clashes over the Nagorno-Karabakh region between the armed forces of Azerbaijan and Armenia in the fall of 2020 (Rauch, 2021). It needs to be emphasized that the former one was largely modernized by Turkey in an ongoing process since the 1990s. This cooperation has intensified over the next years. Drones, in particular, achieve good results in asymmetric warfare, where one side has a major military advantage (Wolfendale, 2021; Jeangène, 2023).

Drones have also been used by guerrilla groups in recent years. It was probably the Syrian guerrilla who was behind the spectacular attack on Russian military bases in that country (Baggiarini, Rupka, 2020; Malaviya, 2020). The operation was carried out by a swarm of drones, which were programmed with specific targets along with the GPS data, thus they were autonomous. Some of the drones attacked a Russian support vessel. The attack was mostly

prevented. The Saudis, however, failed to prevent the attack of 10-25 drones carried out by the Yemen rebels aimed at one of Saudi's largest oil refineries (Johnson, 2020; Behnke, 2020). The anti-aircraft defence system was ineffective due to the low flight path and numerous angles of attack. The operation resulted in a massive fire at this oil installation (Ruschi, 2020; Gusterson, 2019).

Drones are capable of destroying ground targets no worse than bombers. At the same time, being much more precise. Contemporary combat drones are becoming an increasingly important component of weaponry (Bauer et al, 2022).

In order not to waste the potential of the purchased combat drones and the taxpayers' money, the army has to combine innovative technology and new tactics. The drone swarms tactic, in particular, has great potential in terms of innovation (Bergen, Sims, 2021).

The analysis of the respected literature (Fowler, 2014; Aroosa, 2021; Fairehead, 2021; Borg, 2021; Antebi, 2016; Dekel et al., 2017; Benjamin, 2013; Kostenko et al., 2022; Schilling, 2022; Ragab et al., 2022; Soria et al., 2022; Iacovelli, Grieco, 2021) indicates a research gap concerning the use of drones on the contemporary battlefield, in particular regarding the so-called drone swarms. There are publications on drone swarms and drone swarms management, but there are no detailed publications on the military use of this innovation. Swarms of drones can be used in search operations, transport networks or monitoring. The point is for the swarm to not only control its surroundings but also itself and should not need an operator (Kostenko et al., 2022; Schilling, 2022; Ragab et al., 2022; Soria et al., 2022; Iacovelli, Grieco, 2021). It is also possible to use them for military purposes. From the military standpoint, a swarm is an autonomous, interconnected group of small unmanned aerial systems that are working together to achieve a shared objective with the operator on or in the loop. Coordination and responsiveness are what distinguish between a real swarm and the employment of the drones en masse. The latter occurs when a large number of drones are used against a single target, mainly to incapacitate it by overpowering its defences (Gagaridis, 2022).

In particular, no studies focusing on the analysis of the possibility of using simulation methods to manage innovative drone swarms for military purposes were found. This publication tries to fill in this gap by examining the options of employing such innovative solutions in the armed forces.

The objective of this publication is to analyse the possibilities of using drone swarms as an innovative battlefield tool.

The research includes simulation methods by using computer simulation methods based on the so-called random walk – Brownian motion and Brownian bridge. A detailed description of this method can be found in the methodological part of this publication.

2. Literature Review

Until recently, the military had a monopoly on drones and was using them in military operations. They were employed for surveillance, reconnaissance and precision attacks. Drones have become one of the symbols of the fight against global terrorism (Vanžura, 2021; Norris, 2020).

Currently, drones are used by civilians for both professional/commercial purposes (i.e. monitoring places with difficult access, filming important events) and private ones (i.e. bought for children for their first communion and used as toys) (Rahmani, 2020; Gregory, 2020).

Drones are getting smaller in size and cheaper without losing their basic features, which are used by the military (see tables 1-5) (Schulte, 2019; Jones et al., 2019; Gray, 2018). The most important features of modern drones include a live view and a "return to home" option where the default location of the return of the machine can be activated after giving it an appropriate command, mapping the route by using GPS point positioning (Davis, 2022; Gordon et al., 2021).

Table 1.
NATO UAVs Classification 2009

Class	Application
Class I weight: < 150 kg;	Employment: a tactical support unit at a team, platoon or company level; flight time: up to 6h
Class II weight: 150-600 kg;	Employment: a tactical support unit at a battalion or brigade level; flight time: up to 24h
Class III weight: > 600 kg;	Employment: an operational and strategic unit; flight time: up to 40h; important information: high operating altitude (>3000m)

Source: based on: https://pl.wikipedia.org/wiki/Bezzałogowy_statek_powietrzny, 21.03.2024.

Table 2.
UAVs Classification based on the weight

Designation	Weight	Example of UAV
Super heavy	>2000 kg	RQ-4 Global Hawk
Heavy	200-2000 kg	A-160
Medium	50-200 kg	Raven
Light	5-50 kg	RPO Midget
Micro	<5 kg	Dragon Eye

Source: based on: https://pl.wikipedia.org/wiki/Bezzałogowy_statek_powietrzny, 21.03.2024.

Table 3.
UAVs Classification based on the maximum altitude above the sea level

Category	Maximum altitude above the sea level	Example of UAV
Low	< 1000 m	Pointer
Medium	1000-10000 m	Finder
High	> 10000 m	Darkstar

Source: based on https://pl.wikipedia.org/wiki/Bezzałogowy_statek_powietrzny, 21.03.2024.

Table 4.
UAVs Classification based on the application

Category	Application (main objectives)	System name and type
Objective and decoy	Air targer simulation for artillery and rocket shooting	Cele Voodoo, Banshee (firmy Meggitt Defense Systems)
Reconnaissance	Performing reonnaissance on the battlefield	RQ-1 Predator
Combat	Used to attack selected targets	Schiebel S-100 Camcopter, MQ-9 Reaper (Predator B)
Logistic	Used for load handling and other battlefield protection purposes	AirMule (Urban Aeronautics)
Research	Testing new aerodynamics and electronic technologies and solutions	Altair UAV (General Atomics Aeronautical Systems)
Civil and commercial	Performing civil and commercial tasks (monitoring stadiums, boarders, streets)	Eagle Eye (Bell) – US boarder guard, Fulmar (Aerovision) – search for tuna schools

Source: based on Burdziakowski, 2011, pp. 15-20.

Table 5.
UAVs Classification based on UVSI (Unmanned Vehicle Systems International)

Class	Radius	Flight time	Altitude
Nano	1 km	10 min	100 m
Micro	10 km	60 min	150 m
Mini	10 km	120 min	300 m
Close range	30 km	4 h	3000 m
Short range	70 km	6 h	3000 m
Medium range	200 km	10 h	5000 m
Medium altitude long endurance (Male)	>500 km	24 h	13 km
High altitudelong endurance (Hale)	2000 km	>24 h	20 km

Source: based on Borkowski, Łach, Zwierzyna, 2018, pp. 115-130.

In Poland, the latest document regulating the movement of drones is the Notice of the Minister of Infrastructure of July 3, 2009, on the publication of a uniform text of the Regulation of the Minister of Transport, Construction and Maritime Economy on the exclusion of the application of certain provisions of the Act – Aviation Law to certain types of aircraft and determining the conditions and requirements for the use of such aircraft[1]. In addition, the notice of the Marshal of the Sejm of the Republic of Poland on July 19, 2019, on the publication of the uniform text of the Act is also in force – Aviation Law[2]. Moreover, Poland, as an EU member, respects and has implemented EU regulations containing new rules for the use of drones in the EU (UE, 2019/497; UE, 2019/495; UE, 2019/947; UE, 2020/639). Initially, these provisions were to apply throughout the EU from July 1, 2020, but due to the global pandemic the date was postponed to December 31, 2020 (UE, 2020/1058; UE, 2020/746). The European Aviation Safety Agency (EASA) has developed common European rules to ensure the free movement of drones and a level playing field for all operators of the unmanned aerial vehicle systems within the EU. They will allow the UAV operators (the operator of the UAV is any legal or natural person using or intending to use one or more UAVs) to perform drone operations across the EU without any difficulties. These rules rely on the assessment of the risk of

[1] http://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20190001497, 21.03.2024.
[2] http://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20190001580, 21.03.2024.

operating drones and ensure a balance between the obligations of the drone manufacturers and operators in terms of safety, respect for privacy, the environment, and protection against noise and safety. In Polish and European law, there is no longer a division into drone flights "for recreational and sports purposes" and "for purposes other than recreational and sports". Therefore, there is no distinction between "commercial" flights and other "recreational and sports" flights. In Polish law, there is a division into operations performed with the use of UAVs in the visual line of sight (VLOS), beyond the visual line of sight (BVLOS) and in the first-person view (FPV). Of course, the EU law does not resign from the above-mentioned distinction performed by the UAV pilots, however, the main division is related to the risks posed by flights in each category for people on the ground and other airspace users (UE, 2019/945). This division distinguishes three categories:

1. Open Category (also includes three additional flight subcategories: A1, A2, and A3) – the VLOS operations do not require an approval/authorization, the drone mass has to be less than 25 kg and the drones cannot be operated above 120 m (or an obstacle taller than 120 m), where the risk to a third party is close to zero.
2. Specific Category – the VLOS/BVLOS operations have to be performed with a declaration to comply with the standard scenarios or apply for an operational authorization due to the higher risk for third parties in comparison with the Open Category.
3. Certified Category – includes VLOS/BVLOS operations that require UAS certification under Delegated Regulation (EU) 2019/945 and operator certification.

In addition to the division into the types of operations in terms of risk and the sufficient distance from people, the European Commission also introduced a division of drones into classes from C0 to C4 based on the following criteria:

1. C0 (C0 drones can fly in all subcategories of the Open Category) – drones under 250 g and a maximum flight speed of less than 19 m/s with a flight altitude limited to a maximum of 120 m.
2. C1 (C0 drones can fly in all subcategories of the Open Category – A1, A2, A3) – drones under 900 g or ones that generate kinetic energy below 80 J on impact with a human, with a maximum flight speed of less than 19 m/s and a flight altitude limited to a maximum of 120 m.
3. C2 (C2 drones can fly in the subcategories A2 (close to people, minimum 5 m to 30 m) and A3 (no flight over uninvolved people) of the Open Category) – drones under 4 kg that has a free flight mode activated from the apparatus and a limited speed to 3 m/s horizontally, with the flight altitude limited to a maximum of 120 m.
4. C3 (C3 drones are limited to the A3 subcategory (no flight over uninvolved people) of the Open Category – drones under 25 kg that can fly in various automatic modes and have a flight altitude limited to 120 m.

5. C4 (C4 drones are limited only to the A3 subcategory (no flight over uninvolved people) of the Open Category – drones under 25 kg that have no automatic modes apart from the standard flight stabilization.

Europe-wide Standard Scenarios (STS) have been developed for the specific category that allows VLOS and BVLOS flights over a controlled ground area in a populated environment at a maximum altitude of 120 m. For this category, the division into the C5 (VLOS flights, STS- 01 scenario) and C6 class identification labels (BVLOS flights, STS-02 scenario) has also been introduced. In addition, in Poland, the operator can declare to perform operations according to the National Standard Scenario (NSTS – declaration to the NSTS can be submitted until December 2, 2023, and the declaration is valid for 2 years), which has been described in the Guidelines of the President of the Civil Aviation Authority No15-23 (NSTS-01 – NSTA-09).

The Polish legislation precisely regulates the issues related to the civil use of UAVs, and the Civil Aviation Authority is responsible for governing the process of obtaining appropriate qualifications. The registration of operators should be made at the following web address: https://drony.ulc.gov.pl/. Every person operating a drone should register. The registration does not apply only to people who own drones under 250 g with no camera (or other data recording equipment) or toy drones under the EU Directive 2009/48/W.

In addition, every drone operator should coordinate the flight with the Polish Air Navigation Services Agency (PANSA) before performing a flight (PANASA, 2019) and know the Flight Information Region in which the flight is to be performed (Aspoland, 2024).

Therefore, it is time-consuming, expensive and requires extensive knowledge from the operator to obtain the appropriate qualifications. The big question is whether such knowledge and skills supported by appropriate qualifications and certificates are necessary when executing offensive actions during a hybrid war? (Nikitha et al., 2022; Rawat et al., 2021).

The four terrorist attacks of September 11, 2001, proved that in such activities only effectiveness is important and that knowledge and qualifications confirmed by certificates are redundant (Yan, 2020; Li et al., 2019).

3. Methodology

Methods based on simulation techniques, in particular, a random walk (Brownian motion, Brownian bridge) were used to analyze the data on the innovative use of drones on the battlefield in the form of a drone field.

A random walk is a mathematical and physical concept. It determines the random movement of a "particle", wherein successive movements of time the "particle" moves from its current position to another, randomly chosen one. A random walk is therefore an example of a simple

stochastic process, and Brownian motion is an example of it (Delsaulx, 2018; Xie, He, 2022; Bernstein et al., 2022). They directly relate to the chaotic movements of particles in a fluid – all particles move at the same time in different directions and different speeds. A mathematical model of the physical phenomenon of Brownian motion is the Wiener process, which was used to model and simulate one of the stages of the movement of a drone swarm (Xu, Cheng, 2022; Lu, Zhou, 2022).

Definition of the process (Karatsas, Shreve, 1997; Papoulis, 1991):

We call the Wiener process (Brownian motion) a stochastic process
$W = (W_t)_{t\geq 0}$ such that
$W_0 = 0$ almost certainly;
W has independent increments, i.e. for all $0 \leq t_1 \leq t_2 \leq \cdots \leq t_k$ the random variables $W_{t_1}, W_{t_2} - W_{t_1}, W_{t_3} - W_{t_2}, \cdots, W_{t_k} - W_{t_{k-1}}$ are independent;
the variable $W_t - W_s$ is normally distributed $\mathcal{N}\left(0, \sqrt{t-s}\right)$ for all $0 \leq s \leq t$;
the trajectories W are continuous with probability 1.

The Wiener process in the innovative modelling of a swarm took place in a three-dimensional space. This means that each of the drones included in the swarm will move randomly on an XYZ axis. The reflection principle for the Wiener process was applied in the middle phase of the swarm's flight (in stochastic analysis, the assertion that if the path of a Wiener process f(t) reaches a value f(s) = a, then 2a – f(t) (t) > a) is also a path of a certain implementation of a Wiener process; the reflection principle can be derived from the strong Markov property of the Wiener process), which allowed determining a "safe corridor" of the swarm's passage (variable Z). In the corridor, the drones continued to change their position randomly and without any restrictions in relation to the XY coordinates.

In the last stage of the innovative method of drone traffic modelling, it was assumed that the drones have to ultimately reach the target, meaning to reach the appropriate point in the airspace while keeping a random walk until the end. The so-called Brownian bridge (Latała, 2011; Franke et al., 2022; Es-Sebaiy et al., 2021) was used for this purpose. The Brownian bridge, like the Wiener process, is a Gaussian process.

Definition of the process:

For each finite set of indicates $t_1, t_2, \cdots, t_n \in T$ the random variable $(X_{t_1}, X_{t_2}, \cdots, W_{t_n})$ has a normal distribution.

The Brownian bridge is a Gaussian process {X_t }_(t∈|0,1|) with continuous trajectories such that EX_t=0 and Cov(X_(t_1),X_(t_2))=t_1 (1-t_2) for t_1≤t_2. This means that it is enough to condition the Wiener process at t=1-W1=0. Then the two extreme points of time in the process become the "pillars of the bridge" to which the Wiener process is attached to.

In order to make calculations enabling the innovative use of drone swarms on a battlefield, the following assumptions were made in the field of simulation and the modelling process.

1. The simulation – initial conditions:
   - Take-off of 100 drones from the same point – central point (X, Y, Z) = (0; 0; 0).
   - Use of light drones – maximum working load 0,5 kg.
   - Simulation area – 2,8 km2 (the 1st and 4th quadrants of the coordinate system – 1.4 km^2).
   - Simulation time T = 200*t, t = 10 s [t = 2000 s ≈ 34 min].
   - Implementation of the stochastic process – Brownian motion and Brownian Bridge.
   - Drones move autonomously.
   - Drones do not know their targets at the time of take-off.
   - Drones are randomly organized into subgroups.
   - Target – two objects of strategic importance for the aggressor.
2. The simulation: phase one – "wandering" of the swarm:
   - Phase duration: ti ∈ [1;100].
   - Dispersion of the swarm by using a random walk – Brownian motion.
   - Evaluation of the dynamics of the swarm's movement – determining the direction and force of the swarm's dispersion (coordinates: X [m] and Y [m]).
   - Evaluation of the dynamics of reaching a safe corridor by the swarm movement (coordinate Z [m]).
   - Evaluation of a safe corridor for a swarm movement at the height of Z ∈ (80; 100) m.
3. Recognition of two phases of achieving the appropriate height of the swarm:
   - A rapid increase of the swarm's height – Brownian motion.
   - Keeping the swarm in a safe corridor – Brownian motion, the reflection principle for the Wiener process.
   - The simulation: phase two – attack.
   - Phase duration: ti ∈.
   - The drones are randomly divided into two groups.
4. All the drones belonging to a given group have a common end point:
   - group 1: (X, Y, Z) = (940; 460; 0),
   - group 2: (X, Y, Z) = (20; -500; 0).
   - Drones are to reach the designated target by using a random walk – Brownian bridge.
   - The drones are in a safe corridor until ti = 190, then there is a rapid and controlled loss of altitude to the point Z (200) = 0 - the proper phase of the attack.

4. Results

According to the provisions adopted in the research methodology, appropriate calculations were made to analyse the behaviour of innovative drone swarms on the battlefield.

Figures 1-5 comprehensively present the two phases of the attack. The first phase is a stage of the "swarm's wandering". The second phase shows the "random swarm division" and a random walk of the swarm toward the target points. The whole action lasted for about 34 minutes under the simulation assumptions (2000 seconds). There was no contact between the drones and the operator/base at any stage of the simulation.

In the second phase, it is seen that the swarm divides into two groups after it receives information about its targets. The first group consisted of 52 drones and maintained its flight direction. The second group of 48 drones had to make a significant correction of the flight direction to reach their objective.

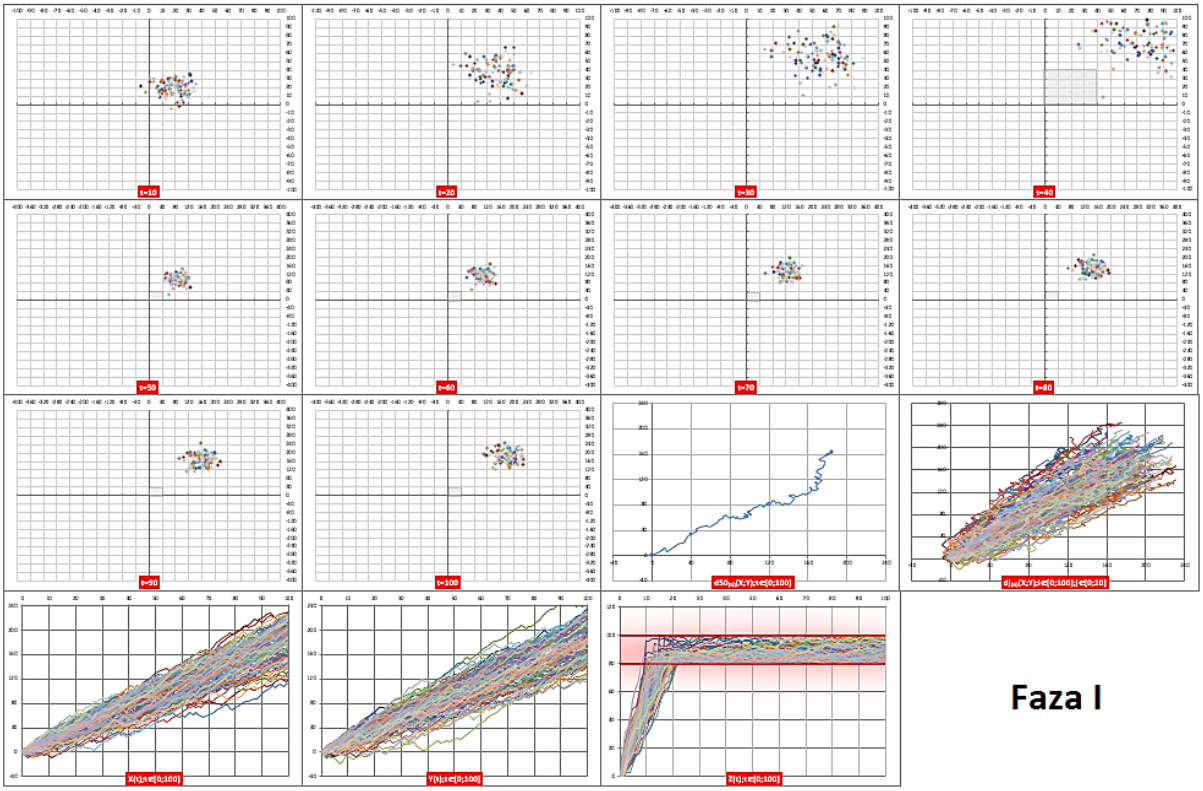

Figure 1. The summary of phase I.

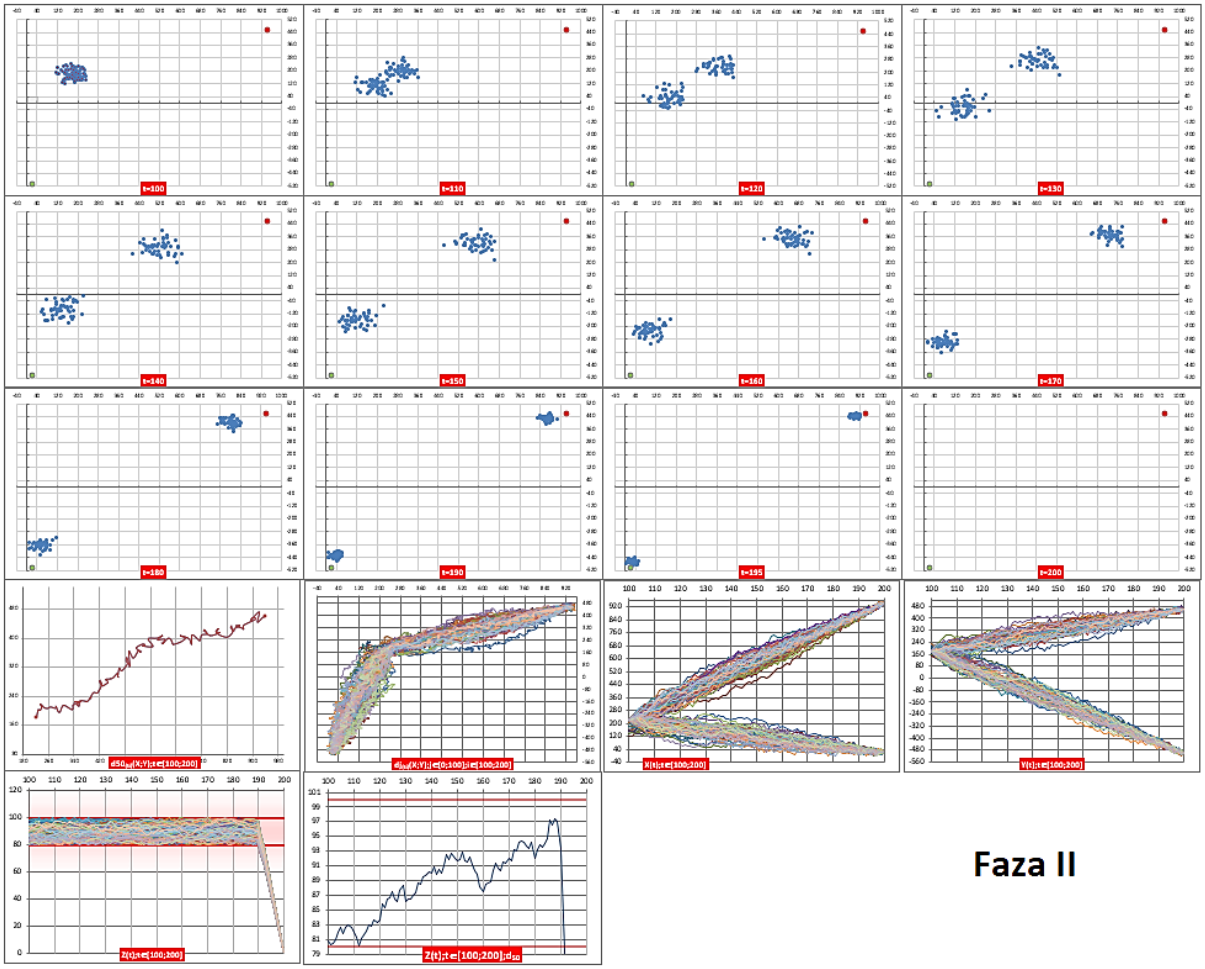

Figure 2. The summary of phase II - a comprehensive coverage.

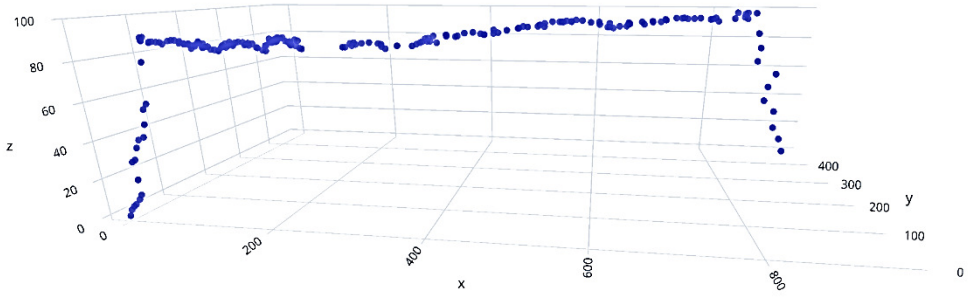

Figure 3. The complete path of a drone showing the movement from take-off to reaching the target - drone no 50.

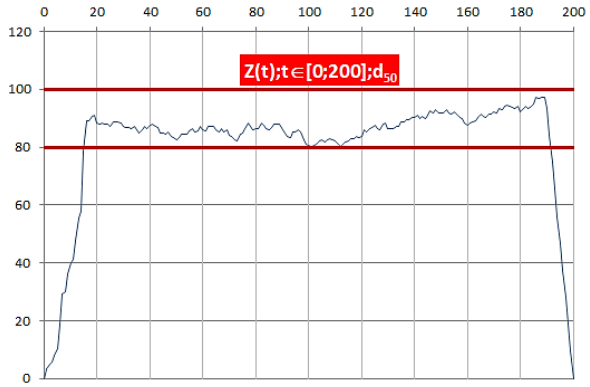

Figure 4. The complete path of a drone showing its movement from take-off to reaching the target with the visualization of a random walk in a safe corridor.

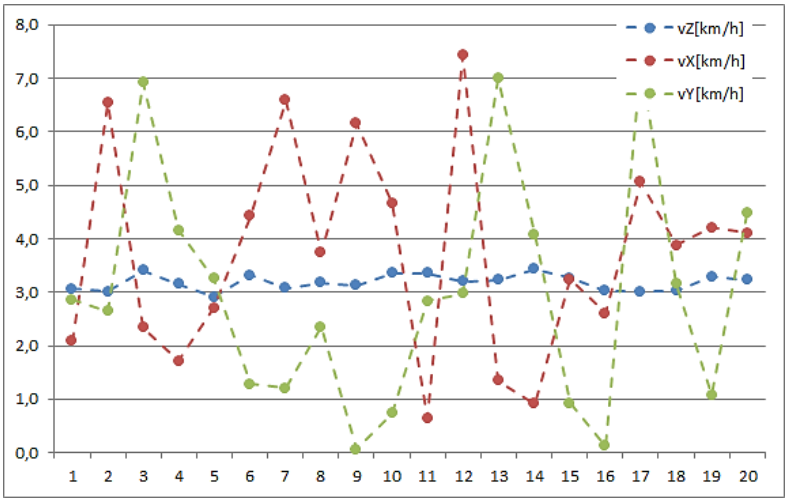

Figure 5. Drones speeds at different levels in the final phase of the attack.

5. Discussion

The innovative capabilities of employing drones operating in a swarm confirm the current results of the use of single drones on the battlefield. Starting from the early research of Benjamin (Benjamin, 2013) to the new research on drones of Antebi (Antebi, 2017) and Borg (Borg, 2021), attention was drawn to the particular use of UAVs in the case of the so-called asymmetrical battlefield. The research discussed in this publication shows that the innovative use of drone swarms will further increase the possibility of employing them in asymmetrical conflict. The innovative solution complies with the requirements of the modern asymmetric battlefield presented by Mack (Mack, 2021), Jacob (Jacob, 2017) and Ciancia (Ciancia, 2012).

It is particularly important to combine the cheapness of the presented solution with the possibility of using it after undergoing a short training and performing an earlier simulation of the effects of the employment of a drone swarm by people having average IT knowledge.

Due to the fact of combining innovations from various areas within the proposed solution, it can be stated that this kind of drone use can be considered an open innovation and can be developed by both the military and civil companies (Ingrassia et al., 2022; Yun, Liu, 2019; Es-Sebaiy et al., 2021; Cooke et al., 2022).

The open innovation character of this solution is evident by the possibility of improving it by the use of the free R software (Alam Khan et al., 2022; Valdez-Juárez et al., 2022).

Currently, you do not have to be an advanced programmer or a mathematician to be able to program. Many ready-made solutions to mathematical problems can be found on the internet, which considers the diversity of programming languages. All it takes is to choose the best solution and adapt it to one's own needs if necessary. Two solutions based on the R language, which was used for modelling and creating the simulation, are presented below. It is possible to improve the proposed solutions thanks to their open innovation character (Naqshbandi, Jasimuddin, 2022).

An example of a function in the R language responsible for the Brownian motion (RDRR)

```
BM <- function(x=0, t0=0, T=1, N=100){
 if(T<= t0) stop("wrong times")
 dt <- (T-t0)/N
 t <- seq(t0,T, length=N+1)
 X <- ts(cumsum(c(x,rnorm(N)*sqrt(dt))),start=t0, deltat=dt)
 return(invisible(X))
}
```

An example of a function in the R language – Brownian bridge (RDRR)

```
BBridge <- function(x=0, y=0, t0=0, T=1, N=100){
 if(T<= t0) stop("wrong times")
 dt <- (T-t0)/N
 t <- seq(t0, T, length=N+1)
 X <- c(0,cumsum( rnorm(N)*sqrt(dt)))
 BB <- x + X - (t-t0)/(T-t0)*(X[N+1]-y+x)
 X <- ts(BB, start=t0,deltat=dt)
 return(invisible(X))
}
```

Currently, the employment of drones does not require a GPS and the physical presence of an operator in the area of operation. All of these characteristics make it possible to destroy or damage more than just military infrastructure. Such activities may focus on logistics, communication, command, critical infrastructure, weapons and military equipment (Baggiarini, Rupka, 2020; Malaviya, 2020; Ruschi, 2020).

According to the authors of this publication, the fact that the innovative solution presented in the simulation is based on a random phenomenon makes this form of attack resistant to drone detection and neutralization (Gao et al., 2022; Mei, Shao, 2016). The possibility of carrying out various attack simulations by using commonly available tools makes this solution an open innovation (Dixit et al., 2022; Ibarra et al., 2017; Amabile, 1996; Lekan et al., 2021).

The innovativeness of the presented solutions and their open character make it possible to use them in a variety of ways with high efficiency (Hizam-Hanafiah, Soomro, 2021; Orzeł, Wolniak, 2022; Olkiewicz et al., 2021).

The popularization, miniaturization, ease of use, and advanced technology of drones are not ignored by the military. At the end of 2017, the Royal Australian Air Force (RAAF) clearly identified in a report the threat resulting from the use of small UAVs – experts are mainly concerned about the development of unmanned micro-devices that can operate without the GPS and find and destroy small targets (Matsatsinis, Marinakis, 2021; Kumari et al., 2020; Krakowski, 2020; Agwu, 2017; Miranda et al., 2020; Zaidi et al., 2022; Saebi, Foss, 2015; Patrucco et al., 2022)[3].

6. Conclusions

Based on the simulation of the innovative use of a drone swarm, the following conclusions were obtained:

1. The size of a swarm depends on the "budget".
2. Each drone operates independently from the rest.
3. The drone does not have to be in contact with an operator (uploading a complete program to the drone's memory).
4. The "swarm" can be divided into any number of subgroups – each subgroup can carry out different tasks or objectives.
5. Acceptability of a high percentage of failures (shooting UAV by appropriate detection and defence systems).
6. Lack of detectability of the attack (employment of small drones and the randomness of their movement makes it impossible to predict the trajectory of the target).
7. The unpredictability of the drone's movements (the next position of the drone is not conditioned by its previous position).
8. Resistance of the "swarm" to interference (no channel of communication between the drones themselves and the drones and the operator).

[3] https://www.aspistrategist.org.au/39608-2/, 21.03.2024); https://pl.sputniknews.com/20180531/ Sputnik-bezpieczenstwo-swiat -technologie-drony-8074395.html, 21.03.2024.

The obtained results prove the existence of substantial possibilities for using innovative swarms of drones on the modern battlefield. The presented solution is very innovative in a way it combines a relatively low cost and ease of use with innovative effects that are impossible to achieve in any other way.

The simulation clearly showed that the innovative use of small UAVs for irregular operations can serve as an alternative to conventional kinetic operations on the battlefield. The innovative effects of the solution result from two main reasons:

- First: the attack can be carried out by pre-trained personnel.
- Second: the costs of the attack are relatively low compared to other traditional measures.

The reasons presented above prove that the proposed solution is highly innovated in comparison to the traditional employment of single drones on the battlefield. Particularly, a lower level of trained personnel is an advantage compared to the classic solution, which increases the possibility of using it in asymmetric conflicts.

The innovative solutions presented in this publication may find a wide application on the battlefield in the future, in particular in asymmetric warfare. This is because the gadgets discussed in the publication can be bought in large quantities and with a small budget.

Thanks to the use of innovations, it is possible to carry out attacks that bypass anti-aircraft defence and destroy expensive equipment and logistics infrastructure at a relatively low cost, which is crucial on the modern battlefield. Currently, in the era of Industry 4.0, which is based on digitization and robotization, it will be possible to increasingly use solutions with the utilisation of artificial intelligence on the battlefield. One of such solutions is the use of innovative drone swarms presented in this publication.

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APPLICABILITY OF SERIOUS GAMES TO PROJECT'S MANAGER COMPETENCIES ASSESSMENT – LITERATURE REVIEW

Marcin OPAS[1*], Marcin WARDASZKO[2]

[1] Kozminski University, Warsaw; mopas@kozminski.edu.pl, ORCID: 0000-0003-3941-1846
[2] Kozminski University, Warsaw; wardaszko@kozminski.edu.pl, ORCID: 0000-0001-5411-7894
* Correspondence author

Purpose: Assessing project manager competencies is a complex but essential factor in ensuring project success. Traditional assessment methods may not adequately address project management's dynamic and multifaceted nature. Serious games have shown promise in education and training, providing a realistic, interactive, and risk-free environment to develop and assess skills. However, their application to project manager competency assessment needs to be explored. The research aimed to investigate the current state of serious games used in project management, particularly their role in assessing project manager competencies.
Design/methodology/approach: The authors use systematic and classical literature reviews and analyze the current research areas of simulation games adoption for project management, learning goals and skills, and assessment models. The literature review findings are compared to the competence model of the IPMA and analyzed for similarities and differences.
Findings: The findings of this research confirm that serious games could be used not only to train but also to assess (certify) the competencies of project managers formally, understood as an assessment of a project manager's ability to apply knowledge, skills, and abilities in practical situations.
Research limitations/implications: The study relies on articles published between 2000 and 2023 and available in English, which may exclude relevant works in other languages or older foundational studies. The selection was limited by the accessibility of articles in specific databases, potentially omitting key contributions from less accessible or alternative sources. The analysis was conducted on only two serious games, which may not represent the full range of serious games available for project management competency assessment.
Practical implications: The research suggests that serious game developers should expand the scope of competencies assessed, including behavioral and contextual dimensions, to offer a more holistic evaluation.
Social implications: By aligning serious games with international competency models like IPMA, the research supports the development of globally recognized standards for project management skill assessment.
Originality/value: The study innovatively uses the IPMA Level C certification process as a benchmark to evaluate the potential of serious games in formal competency assessment. This approach bridges the gap between gamification in learning and formal professional certification standards.
Keywords: serious games, project manager, competencies assessment, complexity.
Category of the paper: Literature review.

1. Introduction

Project management is an increasingly important specialty nowadays. Currently, more than 20% of global economic activity takes place as projects (de Rezende, 2019; Gemunden, 2013), and in some emerging economies, it exceeds 30% (Bredillet C. N., 2010). Moreover, the 'projectification' of organizational work is today observed in almost every industry (Kuura, 2020; Bakker, 2010; Sydow, 2004), and organizations increasingly use projects to achieve their strategic objectives (Morris, 2004).

Effective project management helps organizations improve efficiency and reduce waste, which results in cost savings and improved profitability (Kaufmann, 2022). Organizations skilled in project management can develop a competitive advantage by delivering projects more efficiently and effectively than their competitors (Milosevic, 2003).

With the increasing complexity of projects in various industries (de Rezende, 2019), project management has become a critical skill set for organizations (Maylor, 2017) to successfully complete projects on time, within budget, and with the desired level of quality. There are numerous reasons why project management has become an important profession. In industries such as construction, engineering, IT, and healthcare, there is a need for professionals who can manage these projects effectively. Project management professionals should be trained to plan, organize, and execute projects in a way that ensures their success (Herath, 2021). They should be skilled in identifying and managing risks (Rumeser, 2019), project design, human resource management, communicating with stakeholders, and ensuring project management efficiency. Moreover, they should be skilled in identifying and understanding customer needs and translating those needs into project requirements to ensure that projects meet customer expectations and result in satisfied customers (Chipulu, 2013).

Therefore, assessing project manager competencies is a complex and challenging task; conversely, it is a critical project success factor. Project manager competencies can be assessed through various methods, i.e., performance reviews, behavioral interviews, 360-degree feedback, certifications, or serious games. Serious games are typically created to teach or develop specific skills, knowledge, or behaviors. They can be used in various contexts, including education, training, personal development, and competency assessment. Assessment through serious games can be done in multiple ways, such as scoring a player's performance, evaluating their decision-making skills, measuring their ability to work collaboratively, or testing their ability to solve complex problems. Serious games can also provide a more comprehensive and realistic assessment of competencies than traditional assessment methods, such as exams or written assignments. This is because they allow learners to apply their knowledge and skills in a simulated environment resembling real-life situations (Kriz, 2022).

Nowadays, serious games are a promising new teaching and learning method that has recently emerged in project management (Rumeser, 2018). A considerable body of literature illustrates the benefits of games and gamification for competency assessment purposes (Chin, 2009), but the term "project management competency assessment serious game" is surprisingly rare. This paper aims to review existing project management serious games that assess project manager competencies. The research question of this paper is: are there any serious games that formally assess project manager competencies? The structure of the paper is as follows. Section 2 presents the project manager competency models and their formal certification procedures. Section 3, methodology of the research. In Section 4, a classical literature review on serious games and competency assessment is introduced. Section 5 presents conclusions and future work based on the findings obtained.

2. Formal assessment of project manager competencies

The need for project manager competence assessment is well documented (Soroka-Potrzebna, 2021; Kaklauskas, 2010). The project manager's competence is a factor in the successful delivery of projects (Patanakul, 2009; Stevenson, 2010). Competency frameworks and standards are developed for one specific reason: to assess, develop, and reassess the competencies of project managers. This process should be continuous, and project managers should embrace it to improve their competencies (Marnewick, 2016). Over the past years, several project manager competency models have been developed to define, and some of them formally assess, the knowledge, skills, and abilities required for success in project management (Taket, 2015; Chen, 2008).

Crawford (Crawford, 2005) proposes three project manager classifications: input competencies, which refer to the knowledge and skills that a project manager brings to a job; personal competencies, which are the core attributes underlying a project manager's capability to execute a job; and output competencies that relate to the 'demonstrable' performance that a project manager exhibits within the work environment. Rose (Rose, 2007) gathered project management competencies in a particular company using semi-structured interviews with project managers to analyze the required competencies in project situations. The study identified seven competencies: technical, process, time, client, business, personal, and uncertainty management. Project manager competencies could be deployed into knowledge, skills, and abilities (Ahsan, 2013). Bredin (Bredin, 2013) outlines two archetypes of project manager career models: the competence strategy model and the talent management model. Those are only a few examples of numerous efforts in creating the project manager competency classification model, which did not evolve into the formalized competency assessment process. This gap is filled by professional associations or other professional

organizations that gather experience from the best specialists. Based on their basis, methods of conduct and training for future project managers are developed. There are many specialized project management methodologies, such as PMBoK® Guide, PRINCE2®, PCM, TenStep, HERMES, and others described in the literature (Trocki, 213, 2017; Svejvig, 2015; Morris, 2013) but only a few of them include project manager competency models (Eskerod, 2013). Similarly to Bredillet (Bredillet, 2015), in this research, we have selected three standards that have been published by long-established bodies or/and account for a large number of credentialed project managers - Global Alliance for Project Performance Standards (GAPPS), Project Management Institute (PMI) and International Project Management Association (IPMA).

The Competency Baseline for Project, Program, and Portfolio Management (CBP) is a standard developed by the GAPPS that outlines the competencies required for successful project, program, and portfolio management (Global Alliance for Project Performance Standards. A Framework for Performance Based Competency Standards for Global Level 1 and 2 Project Managers, 2007). The CBP identifies 46 competencies across three levels of management: project management, program management, and portfolio management. These competencies are grouped into five Units of Competency focused on project processes, i.e., management of relationships with stakeholders, development of the plan for the project, or project progress management. Unlike IPMA or PMI, the GAPPS is a volunteer organization working to create such frameworks and standards by providing a forum for stakeholders from differing systems, backgrounds, and operating contexts to work together to address the needs of the global project management community. Therefore, CBP can be freely used by businesses, academic institutions, training providers, professional associations, and government standards and qualifications bodies globally. Still, they are not formalized as an official assessment (certification) standard.

The PMI's Talent Triangle was recently updated (PMBOK Guide - Seventh Edition, 2021) but remains a framework that outlines the three key areas of competencies required for success in project management: ways of working (formerly - technical project management), power skills (formerly – leadership), and business acumen (formerly- strategic and business management). The detailed framework for defining, assessing, and developing project manager competence is described in Project Manager Competency Development (PMCD) Framework (Project manager competency…, 2017) that is consistent with the Talent Triangle. The PMCD Framework structure represents a typical competency standard. It identifies:

- Units of Competence. Each Unit of Competency in this Chapter of the PMCD Framework corresponds to one of the five Project Management Process Groups: Initiating, Planning, Executing, Controlling, and Closing.
- Elements of Competence. Each Unit of Competence consists of several Elements that reflect the activities in which project managers are expected to be experienced.

- Performance Criteria. Each Element is described by Performance Criteria, which specify the outcomes to be achieved to demonstrate competent performance.
- Types of Evidence are associated with each of the Performance Criteria. These form the basis upon which competence can be self-assessed.

PMCD framework describes competence as consisting of three separate dimensions:

- project management knowledge competence—what the project manager knows about project management,
- project management performance competence—what the project manager is able to do or accomplish while applying project management knowledge,
- personal competency—how the project manager behaves when performing the project or activity.

Even though PMI's project manager certification system is one of the most reputable and recognized worldwide, it is important to highlight that it is not based on PMCD Framework but on PMBoK® Guide mastery. Furthermore, the certification requires a defined length of professional experience, depending on the applicant's academic credentials. Therefore, the PMCD Framework is used by PMI as a reference guide for project managers in their professional development, not as a formalized project manager competency assessment standard.

The IPMA Competence Baseline (ICB) does not discuss competencies in terms of specific roles (e.g., project manager) but rather in terms of the domain (e.g., individuals working in project management). The rationale is that roles and role titles vary greatly by language, industry, and focus. Therefore, the ICB presents important project management, program management, and portfolio management competencies. Each domain may contain roles and titles that fit into the overall competence domain. ICB is organized into three areas: technical competencies, behavioral competencies, and contextual competencies (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015).

Figure 1. IPMA's Eye of Competence.

Source: (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015).

According to ICB, people competencies are personal and interpersonal competencies required to successfully participate in or lead a project, program, or portfolio. Practice competencies are the specific methods, tools, and techniques used in projects, programs, and portfolios to realize their success. Perspective competencies are methods, tools, and techniques through which individuals interact with the environment and the rationale that leads people, organizations, and societies to start and support projects, programs, and portfolios. Within each competence area, there are generic competence elements (CE) that apply to all domains. CEs contain lists of the pieces of knowledge and skills required to master the CE. Key competence indicators (KCI) provide the definitive indicators of successful project, program, and portfolio management for two or all three domains. Measures exist that describe highly detailed performance points in each KCI.

Competence in the project domain is broken into 28 CE with one to many KCI each.

Table 1.
IPMA project KCIs (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015)

Area No.	**CE No. & Description**
4.3 Perspective	4.3.1. Strategy
	4.3.2. Governance, structures and processes
	4.3.3. Compliance, standards and regulations
	4.3.4. Power and interest
	4.3.5. Culture and values
4.4 People	4.4.1. Self-reflection and self-management
	4.4.2. Personal integrity and reliability
	4.4.3. Personal communication
	4.4.4. Relationships and engagement
	4.4.5. Leadership
	4.4.6. Teamwork
	4.4.7. Conflict and crisis
	4.4.8. Resourcefulness
	4.4.9. Negotiation
	4.4.10. Result orientation
4.5 Practice	4.5.1. Project design
	4.5.2. Requirements and objectives
	4.5.3. Scope
	4.5.4. Time
	4.5.5. Organization and information
	4.5.6. Quality
	4.5.7. Finance
	4.5.8. Resources
	4.5.9. Procurement
	4.5.10. Plan and control
	4.5.11. Risk and opportunity
	4.5.12. Stakeholders
	4.5.13. Change and transformation

To assess the project manager's competency, IPMA developed the IPMA Four Level Certification (IPMA 4-L-C), where a candidate's competence level is evaluated by assessors trained in the IPMA certification assessment process. The project manager assessment process may vary depending on the certification level and National Certification Body regulations.

This research used Polish rules and procedures (IPMA Polska Certyfikacja, 2023). At level D, designed for individuals new to project management or with limited experience, the certification process involves completing a written exam and a self-assessment, which evaluates the individual's project management knowledge and skills. Level C is designed for project managers with several years of project management experience, and the certification process involves completing a written exam and assessment center (or individual interview). Level B is designed for senior project managers who have significant project management experience and have managed complex projects. The certification process involves completing a written exam, report, and an assessment center (or individual interview). Level A is designed for individuals with extensive experience managing multiple projects or programs. The certification process involves the presentation of recommendation letters, a written report summarizing project management experience, and an assessment center.

As discussed above, among three selected competency standards, IPMA ICB is the only competency standard that was formalized and operates as an actual project manager assessment (certification) body worldwide. Therefore, further research will use the IPMA Level C certification process as a competency assessment model to seek its utilization in project management serious games design, development, and actual embracement.

3. Methodology

The initial research was based on a systematic literature review methodology (Okoli, Schabram, 2010). Three key phrases were selected: project manager, competencies assessment, and serious games. They were searched for in the most recognized databases, including EBSCO, ScienceDirect, Scopus, Web of Science, and SAGE journals – in the time frame of 2000-2023. The initial search revealed 16.064 articles. After the initial title and abstract screening, 51 articles were selected for further investigation. Articles were chosen based on exclusion criteria. The first exclusion criterion was the lack of one of the adopted keywords (project manager, competency assessment, and serious games) because it pointed to the lack of relevance for the subject and indicated other areas of research (e.g., higher education, pedagogy, 21st-century skills, children's education). Also, metaphorical (or random) uses of keywords were excluded – for instance, "project-oriented", "competent manager", and "Game Theory". Articles were expected to have been published no earlier than 2000 because the number of serious games in the literature increased exponentially then. Repeated game cases described in other articles were excluded as well. The last exclusion criterion was unspecified or non-assessment embeddedness of the game. The next phase consisted of full screening and selection based on inclusion criteria. Only the articles that indirectly referred to the project manager competency model were supposed to be considered. It was important to find cases explicitly

addressing project manager assessment considering their characteristics. It was supposed to be verified by checking the goals of the games. Only the cases contributing to the project manager assessment or its derivatives would be considered. Finally, the research would not include games if there was insufficient information about game design. None of the reviewed articles fulfilled the selected criteria.

Due to the failure of the systematic literature review methodology, the classical literature review methodology was adopted. Firstly, serious games and areas of their applicability were reviewed. Based on the review findings, the education and training simulation games category was selected for further research from the perspective of project management competency development. Then, serious gaming and its competency assessment aspect were explored, focusing on adopting the project manager competency model. Finally, examples of project management serious games were presented as a basis for conclusions and findings.

4. Serious games and competency assessment – literature review

4.1. Serious games applicability

The serious game term was defined in 1970 (Abt, 1970). However, it referred to board games rather than video games. Since then, numerous authors have investigated the serious games concept (e.g. Connolly, 2012; Djaouti, 2011; Michael, 2005; Wouters, 2013; Zyda, 2005). Zyda's definition of a serious game as "a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives" (Zyda, 2005), was extended by Michael and Chen (Michael, 2005) who added that serious games "do not have entertainment, enjoyment, or fun as their primary purpose" to emphasize that serious games are designed for purposes beyond entertainment. However, for the project management environment simulation, an interesting perspective is the usage of game artifacts (form) to simulate (function) the system processes of a complex (real) system (Duke, 1974; Klabbers, 2009). Kriz et al. (Kriz, 2022, p. 4) define a serious game as "a reconstruct of important aspects of the reference system; therefore it is an abstract model of reality with less complexity and fewer details". The major challenge of project management is its complexity and decision-making in a rapidly changing environment. Therefore, the simulation of a simplified reality model lays solid grounds for various applications of serious gaming in project management.

Serious games are typically created to teach or develop specific skills, knowledge, or behaviors and can be used in various contexts, including education, training, and personal development. According to (Kriz, 2017), gaming simulations can be categorized taking into consideration the following perspectives:

- an analytical science perspective leads to the usage of games and simulations as scenarios to empirically test, justify, and develop theories in specific domains,
- the design perspective emphasizes the usability of simulation games and their objective to promote and evaluate their development and use in a practical context.

Serious games can take many forms, including board games, behavior-oriented role plays, with or without computer-assisted simulation elements, and, more recently, digital and non-digital educational games, game-based learning, and web-based simulation games. According to Kriz et al. (Kriz, 2022), the application of serious games can be categorized as follows:

- education and training simulation games, where they promote knowledge acquisition of the development of skills, competencies, attitudes, and values, and the understanding of complex relationships,
- simulation and game-based policy interventions, where they support the testing and evaluation of alternative strategies and courses of action,
- gaming simulation as a core method for designing complex sociotechnical systems, where gaming applications may facilitate the (re)design of organizational rules, structures and performance, workflow processes, and human factors.

From the project manager competency assessment perspective, education and training applicability are most promising, as learning can significantly influence personal competencies. Moreover, facilitating the understanding of complex relationships is of key importance for the project management area.

4.2. Serious games and learning

Definitions of learning differ enormously in psychology, neuroscience, behavioral ecology, evolutionary theory, and computer science, as well as in many other disciplines, and new definitions continue to be proposed (Barron, 2015). As it comes to the discussion of learning in games, most frequently Kolb's model of Experiential Learning Cycle (ELC) appears (Kolb, 1984), where learning optimally is a cyclic, four-step process of Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation (Kolb, 1984). In serious games gaming, participants are offered an environment close to reality, where they can experience situations and make decisions without risking trouble in real life (Kriz, 2022). In Kolb's model, the learning subject should reflect on and "work with" his/her experience. The typical structure of serious games reinforces specific experiences and the realization of other ELC steps. Breaks for observation and conceptualization before continuing with experimentation are advised. The very important debriefing is represented in the ELC (Reflective Observation and Abstract Conceptualization) (Schwagele, 2014). Research has shown that serious games can be an effective tool for learning, as they engage learners in active and experiential learning (Dekanter, 2005; Karney, 2007), which can enhance knowledge retention and transfer. Unlike passive knowledge transfer, learners are drawn into an active,

experience-based learning environment (Leigh, 2005). Gaming simulation can be characterized as prime examples of cooperative, experience-oriented (Kolb, 1984; Jones, 1997), problem-based, and primarily self-organized (Kriz, 2010, 2014) methods of learning and education. Serious games can also create a safe and controlled environment where learners can practice and apply new skills without fear of failure or negative consequences (Kriz, 2022). Therefore, it is not a surprise that there is a continuous number of areas where serious games are used as a mechanism to teach or improve skills, such as in language teaching (Patino, 2014), sex education (Kwan, 2015), or enhancing doctor or nurse communication (Zielke, 2015). This trend can also be observed in the project management discipline, where an increasing number of project management games have been proposed since their introduction in 1974 (Estes, 1974). According to (Rumeser, 2018) the number of project management serious games suggested in the literature has increased exponentially in the last two decades (from a couple per year in the 70s of the 20th century to 80 in 2018). The authors have identified the following three types of simulated projects in the games: games with no specific project type (general), games that simulate Information Technology (IT/software) projects, and games simulating Engineering, Procurement, and Construction (EPC) projects. Most project management games (43%) simulate EPC projects, 35% of games are played in an IT/software project context, and 23% have no project context. Project management games are predominantly played in a single project setting (86%), in one of or a combination of the three project phases (planning, execution, and control), the majority of them (64%) are single-player games and in most cases are digital-based or computer-based (87%).

4.3. Serious games as an assessment tool

As serious games are designed to simulate real-life scenarios, they can be used to assess competencies (Kriz, 2022). There are numerous definitions of the term “competence” (e.g. Boyatzis, 2008; Hoffman, 1999), and it has not been clearly defined in the literature (Robotham, 1996). In this research project, individual competence is the application of knowledge, skills, and abilities to achieve the desired results (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015). Consequently, competency assessment is understood as an assessment of the learner's ability to do so in practical situations. Therefore, as mentioned earlier, a safe and controlled environment allows practicing and applying professional skills, which is another positive aspect of serious games’ applicability to project manager competency assessment.

Assessment through serious games can be done in various ways, such as scoring a player's performance, evaluating their decision-making skills, measuring their ability to work collaboratively, or testing their ability to solve complex problems. Serious games can also provide a more comprehensive and realistic assessment of competencies than traditional assessment methods, such as exams or written assignments. This is because they allow learners to apply their knowledge and skills in a simulated environment resembling real-life situations

(Kriz, 2022). Furthermore, serious games can provide immediate feedback to learners, allowing them to understand their mistakes and correct them in real time, enhancing their learning and performance (Kriz, 2022). Considering that an assessment center is an inherent component of the IPMA 4-L-C system based on immediate feedback from project management senior experts, this quality of serious games can be seen as a significant asset.

Serious games often use various competency models to design and evaluate learning outcomes. Using a competency model as a guide, serious game designers can ensure that the game content and scenarios align with the specific competencies that learners need to develop. This can help to make the game more effective at achieving its learning objectives. Competency models in serious games can vary widely depending on the specific game and its intended purpose. Therefore, there are numerous competency models used in serious games across different domains, and a single game may include several competency models. For example, one of the most popular Microsoft games, Flight Simulator (Flight Simulator, 2023), is, on the one hand, based on the Dreyfus Model of Skill Acquisition (Dreyfus, 1980) and, at the same time, incorporates International Air Transport Association (IATA) pilots competencies model and assessment framework (Competency Assessment…, 2023). Another worldwide recognized serious game, World Climate Simulation, includes several theoretical models, including competency ones, such as Hersey and Blanchard's Situational Leadership Model (Hersey, 1969), Collaborative Leadership (Gumus, 2018), interest-based negotiation model developed by Fisher and Ury (Fisher, 1981) and their numerous followers as well as the collaborative problem-solving model initiated by Dewey (Dewey, 1933) and then refined by several scholars and practitioners over several decades.

Serious games can also be used to assess competencies based on the same competency model that was used to design the game. For example, a game designed to develop leadership competencies might use a competency model that includes skills such as communication, decision-making, and team building. The game could then assess the player's performance in these areas to provide feedback and track their progress. Using a competency model in serious game design and assessment can help to ensure that the game is focused on the most relevant and important skills and knowledge for a given role or situation. It can also help to provide a clear and consistent framework for measuring and evaluating competency development. A growing number of serious games are used to certify competencies in various fields formally. Flight simulators are used to train and certify pilots in a safe, controlled environment. These simulators can replicate various conditions and emergencies that pilots may encounter in the real world, allowing them to demonstrate their knowledge and skills in a controlled setting. Boeing 737-full flight (Boeing 737 MAX full-flight simulator, 2023), Airbus A-320 (Full Flight Simulators, 2023) or Cessna172 (Full Flight Simulators, 2023) are only a few examples of simulators that are often used as part of comprehensive training and certification program for pilots. Medical simulators are used to train and certify healthcare professionals in various skills and procedures, such as surgical techniques, diagnostic imaging, and emergency medicine.

These simulators can provide a realistic and immersive learning experience, allowing learners to practice their skills in a safe and controlled environment. For example, Lap Sim (LapSim, 2023) is used for laparoscopic surgery training and assessment, da Vinci Surgical System (Da Vinci, 2023) for robotic-assisted surgery training and assessment or VirtaMed ArthroS™ (Medical training simulators, 2023) for arthroscopic surgery training and assessment.

4.4. Project management, serious games, and competencies assessment

The main purpose of the research was to review the literature, investigate the application of serious games in project management, and analyze their utilization for the project manager competency assessment. The research question was: are there any serious games that formally assess project manager competencies? The identification and selection of games were the subject of several stages. From January 2023 to May 2023, intensive research was systematically performed using multiple sources, i.e., research papers, international gaming awards, and contacts with experts, to identify the project management games available. This investigation led to the identification of over thirty serious games that were relevant to the scope of research, i.e., Construction Project Management Game (Hassan, 2021), GRAPM (Miler, 2016), SiMSE (Navarro, 2004), DELIVER! (von Wangenheim, 2012), PMQUIZ (Petri, 2016) and others. However, a selection was required to select the games that were suitable for the scope of the research. The following criteria were followed to undertake this selection:

- the game should be available and used for project management training,
- adequate and publicly accessible documentation should be available to evaluate the game's applicability to the competency assessment process,
- the serious game scoring system should assess the player in as many CEs as possible using IPMA's project manager competency assessment model.

As a result, two games were selected. The first is SimulTrain (SimulTrain, 2023), developed by STS Sauter Training & Simulation SA (STS). SimulTrain is a project management simulation that allows participants to manage a virtual project from start to finish. Its general objective is to train in three fundamental areas, divided into various learning points. The first one is project leadership, where participants learn to lead a project in its entirety, which includes dealing with the project's stakeholders, the project's functions complexity, and priorities management. The second one is project management, where participants learn to manage a project on a day-to-day basis by making decisions which being a project manager requires updating, planning, checking progress, managing quality, and organizing project reviews. They also learn how to make decisions as a team. They have to make decisions requiring them to negotiate cost, deadline, quality, and motivation goals, as well as manage conflict within the team and consider each participant's views. The last one is resource management, designed to teach how to plan the involvement of resources for maximum efficiency. There are eleven simulated project manager functions, such as project planning, budgeting, risk management, decision-making, or project controlling.

Figure 2. SimulTrain users dashboard.

Source: SimulTrain, 2023.

SimulTrain is primarily used in combination with classroom activities but can also be played completely online. Training is conducted with teams of four participants where learners play the role of the project manager. The teams must plan and execute a typical mid-sized project in two or three sessions of 3-4 hours each. The teams are confronted with many situations requiring quick decisions while considering all project parameters (cost, deadlines, quality, and human factors). The teams are scored against five parameters: cost, schedule, quality, motivation, and risk. The trainer can adjust the weight of each parameter to accomplish various learning objectives, i.e., focus of players on project cost management. The SimulTrain is used in trainings for project managers, project participants, top management, managers and their reports, and students of business schools and technical universities. The game is available in more than 22 languages, and there are up to 10 scenarios, reflecting project simulations in different areas. According to STS, the simulator is used in more than 51 countries and has contributed to the training of more than 200.000 project managers (About STS, 2023).

The second one is "Project Management" (PM), developed by REVAS (Games, 2023). Similarly to SimulTrain, it is a simulation that allows participants to manage a virtual project from start to finish the game and its main objective is to train in three fundamental areas of project leadership, operational management, and resource management. Players can play individually or in small (three to four people) teams. The game scenario starts with the endeavor orientation session, where project objectives and stakeholders are identified, and the company's organizational structure, budgets, and resources are reviewed. In the second part, players are expected to develop the project plan, including the project's schedule, budget, resource allocation, and risk management plan. The third phase focuses on project execution with several rounds, each representing one calendar month. To simulate real-life project challenges, unexpected events are introduced, such as late materials delivery, conflict with stakeholders, or project team members getting sick. During the game, players score against eight key competence areas presented in Figure 3.

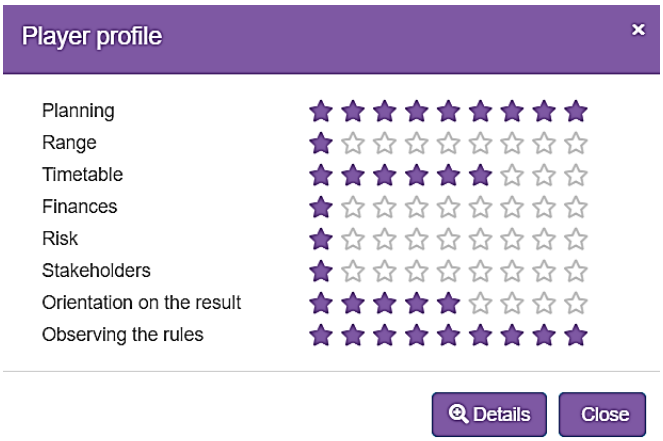

Figure 3. "Project Management" player's profile.

Source: Games, 2023.

The PM game is available in three languages (Polish, English, and Ukrainian). It has four scenarios: new product introduction, research lab launching, training course organization, and implementation of the project management approach in the organization. REVAS game is used primarily to train business audiences and students at higher levels of education in Poland.

Based upon reviewed documentation, the first research criteria were fulfilled as both games present a similar approach to game design as they create a virtual yet simplified project management reality in various environments and cover the overall project life cycle from its initiation to closure. This characteristic lays solid grounds for numerous competency assessment measures. They are accessible online and used to train professionals or students, making them practical examples of the serious game assessing project manager competencies. The analysis of the available descriptions of player scoring systems in both games brought interesting findings. Out of the twenty-eight IPMA CEs, only five are scored in the case of Simul Train and eight in PM simulation. The scoring systems review results are presented in Table 2.

Table 2.
Coverage of IPMA CEs in selected serious games

Area No.	CE No. & Description	SimulTrain	PM
4.3 Perspective	4.3.1. Strategy		
	4.3.2. Governance, structures and processes		
	4.3.3. Compliance, standards and regulations		
	4.3.4. Power and interest		
	4.3.5. Culture and values		
4.4 People	4.4.1. Self-reflection and self-management		
	4.4.2. Personal integrity and reliability		
	4.4.3. Personal communication		
	4.4.4. Relationships and engagement		
	4.4.5. Leadership		
	4.4.6. Teamwork		
	4.4.7. Conflict and crisis		
	4.4.8. Resourcefulness		
	4.4.9. Negotiation		
	4.4.10. Result orientation		

Cont. table 2.

4.5 Practice	4.5.1. Project design		
	4.5.2. Requirements and objectives		
	4.5.3. Scope		
	4.5.4. Time		
	4.5.5. Organization and information		
	4.5.6. Quality		
	4.5.7. Finance		
	4.5.8. Resources		
	4.5.9. Procurement		
	4.5.10. Plan and control		
	4.5.11. Risk and opportunity		
	4.5.12. Stakeholders		
	4.5.13. Change and transformation		

5. Conclusions and suggestions

The article suffers from a lot of limitations. The article sample was limited to both period and online availability, search engines, and language (English). The authors are aware that there are significantly more articles and papers published in the area of concern and that the selection is limited due to the methods applied and other constraints. The authors' future efforts will aim to broaden and study the underlying design methodologies, narratives for serious game design, and project management competency assessment methods in more detail. The planned future work aims to extend the classifications of project management serious game usage and look for opportunities to create a model of the project manager competency assessment serious game to improve the project manager education and assessment process.

This research confirms that serious games could be used not only to train but also to assess (certify) formally project managers' competencies, understood as an assessment of a project manager's ability to apply knowledge, skills, and abilities in practical situations. Firstly, they are designed to simulate real-life scenarios. Therefore, assessing competencies is more realistic and comprehensive as project managers apply their knowledge and skills in a simulated environment resembling real-life situations. Secondly, serious games may simplify the major challenge of real-world project management – their complexity, as serious games are an abstract model of reality with less complexity and fewer details. Thirdly, serious games can provide immediate feedback from senior project management experts to project managers, allowing them to understand their mistakes and correct them in real time. At the same time, senior management experts' observations and performance evaluations can also be used to perform the project manager assessment center role. However, the analysis of the two selected project management serious games depicts the current deficiencies of game-based project manager competencies assessment compared to the IPMA Level C assessment process. The first one is that only a few of twenty-eight project manager competencies are assessed, which results in

a very selective assessment of a minority of them. Additionally, as game scenarios focus on project life cycle management, their scoring systems reflect the project operational management mastery level, not the overall project manager competencies assessment. Finally, although the briefing sessions are foreseen in games' scenarios, their ultimate objective is reflection or discussion of activities performed, not a formal assessment of project management competencies in an interview or assessment center. Such a situation creates a research opportunity through the identified research gap in finding the balance between game design, the IPMA competence model, and simulation games as an assessment tool. It also creates the challenge of marring the diverging angles of these competing research areas.

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USING GENAI IN IT PROJECT MANAGEMENT: CASE STUDIES, INSIGHTS AND CHALLENGES

Sławomir OSTROWSKI

Gdańsk University of Technology, Faculty of Management and Economics; slawomir.ostrowski@pg.edu.pl, ORCID: 0000-0002-1969-0844

Purpose: This study examines the potential of integrating Generative Artificial Intelligence (GenAI) into IT project management, with a view to identifying how it could transform project management processes.
Design/methodology/approach: A case study approach was employed in order to analyse IT companies across a variety of industries. In order to gain a comprehensive understanding of GenAI's applications and impact, the research combined qualitative interviews with project managers and technical leads with quantitative analysis of project performance metrics.
Findings: The results demonstrate GenAI's capacity for markedly enhancing project management, encompassing enhanced project efficiency, more effective risk management, and more efficacious stakeholder communication. Key applications include predictive analytics for risk identification, resource optimisation algorithms to mitigate bottlenecks, and automated quality assurance tools for defect detection. However, challenges such as data quality, algorithmic bias, organisational resistance, and the necessity for transparent AI frameworks were also identified.
Research limitations/implications: The findings, based on IT companies, may have limited generalizability to other industries. The study primarily addresses short-term impacts, with long-term implications yet to be explored. Future research should examine GenAI's applicability in different sectors, its ethical considerations, scalability, and integration with traditional project management frameworks.
Practical implications: Organisations can use GenAI to overcome long-standing project management challenges. The case study examples presented in the article demonstrate GenAI's ability to manage the complex dynamics of IT projects, making it an invaluable tool for IT professionals seeking to optimise project outcomes.
Originality/value: This study contributes to the limited research on GenAI in IT project management by presenting empirical evidence from case studies. It offers actionable insights for practitioners and proposes directions for future research, including exploring long-term impacts, ethical implications, and hybrid methodologies integrating GenAI with traditional frameworks.
Keywords: Generative Artificial Intelligence, GenAI, Project Management, IT Project Management, GenAI in PM.
Category of the paper: Research paper.

1. Introduction

The advent of Generative Artificial Intelligence (GenAI) represents a pivotal moment in the evolution of technology, exerting a significant influence across a range of sectors, including information technology (IT) project management. GenAI comprises sophisticated machine learning models that are capable of creating content, generating solutions and solving complex problems autonomously based on specific inputs and constraints. Such capabilities facilitate the automation of intricate tasks and enhance decision-making processes, rendering GenAI a particularly pertinent technology in the context of the dynamic landscape of IT project management. The IT sector is distinguished by a high degree of complexity and rapid development cycles, which in turn requires the implementation of innovative approaches to the effective management of resources, schedules and risks. Conventional project management methodologies are often insufficient for addressing the growing volume and intricacy of data, evolving expectations of diverse stakeholders, and the necessity for continuous innovation. The complexity and demands of IT projects have increased, necessitating the implementation of effective management strategies to ensure their success. In this context, project management assumes a pivotal role in orchestrating the tasks, resources, and stakeholders in a manner that ensures the efficient achievement of project objectives within defined constraints. Nevertheless, the efficacy of project management methodologies is subject to question in light of the inherently dynamic and complex nature of IT projects.

The ability of GenAI to generate predictive insights, optimise workflows, and support real-time decision-making makes it a uniquely positioned technology to address these challenges. By enhancing operational efficiency and strategic foresight, GenAI offers a transformative tool for IT project managers to navigate the intricacies of modern projects.

Despite the considerable promise that GenAI holds for the field of IT project management, it remains a relatively unexplored area within both academic and practical discourse. While existing studies have provided extensive examination of the integration of artificial intelligence in broader organisational functions, limited attention has been paid to the specific use cases and impact of GenAI in managing IT projects. The extant literature frequently concentrates on general AI applications, thereby neglecting the distinctive characteristics and demands of IT project environments. These include adaptive planning, cross-functional collaboration, and rapid technological shifts.

Furthermore, the potential of GenAI to enhance decision-making, resource optimisation, and project lifecycle management has yet to be systematically studied. There is a dearth of empirical evidence on how GenAI tools can be tailored to align with established project management methodologies, such as Agile, Scrum, or Waterfall. Addressing these gaps is crucial for understanding how GenAI can be effectively leveraged to improve IT project outcomes.

Anticipating challenges, dealing with disruptions and minimising risks have constituted the core responsibilities of project management professionals for decades (Tominc et al., 2023). Furthermore, they are an integral component of contemporary discourses pertaining to the prospective applications of GenAI in project management. Despite their daily familiarity with these concepts, many project professionals may find themselves ill-prepared for the manner in which their organisations will utilise GenAI, as well as the precise impact that it will have on their work. While it is not possible to predict the full extent of the impact that GenAI will have on business operations and processes, it is clear that this emerging technology will enhance the role of many workers, including project professionals. GenAI is having a significant impact on the structure of project work (Curcirito et al., 2023). In light of the accelerated pace of development and adoption of GenAI, there is an increasing imperative for project professionals to cultivate expertise in artificial intelligence. This will result in increased productivity, efficiency and project success (Taboada et al., 2023).

For those in project management roles, GenAI has the potential to automate a range of complex tasks across multiple project activities. These include the generation of reports, updates to schedules, data analysis, cost estimation, and more. Those project professionals who are able to harness the power of artificial intelligence will ultimately be able to free up their time and focus on higher value tasks that contribute to project success. Consequently, project professionals are able to dedicate more time and attention to the generation of new business value, the development of leadership skills and the advancement of innovation within the organisation, in alignment with the organisation's business objectives (Kerzner, 2017).

This paper presents the findings of a study conducted on the data extracted from ten IT companies currently utilising GenAI. The objective is to demonstrate how GenAI can facilitate project management activities within IT companies. To this end, the paper will present a series of practical examples from IT companies, illustrating the potential benefits of integrating GenAI into project management.

2. Literature review

Prior research has examined the incorporation of technology into project management methodologies, underscoring its capacity to enhance project performance and outcomes. Although it is unlikely that artificial intelligence will entirely supplant the role of the programmer in the near future, if ever, it is already capable of markedly enhancing the quality and productivity of IT departments (Taboada et al., 2023). As posited by Wolf and Company, AI has the potential to enhance the efficiency of programmers by up to 10 times by the year 2030 (Curcirito et al., 2023). As reported by McKinsey, over half of companies are utilising AI in at least one business area (McKinsey&Co, 2024). An analysis conducted by Goldman Sachs

suggests that AI could potentially displace 300 million full-time positions while simultaneously enhancing global productivity by 7% (McKinsey&Co, 2024). The statistics pertaining to the integration of AI and project management are noteworthy. As indicated in a Gartner report, the use of AI in project management is expected to reach 80% by 2030, representing a significant increase from the current 2% (Gartner, 2024). A further survey conducted by PMI revealed that 81% of project managers consider AI to be a significant factor in the future of project management (Grandview Research, 2024; Maphosa et al., 2022). The results of recent research appear to reinforce the view that the use of AI in the field of project management is beneficial. As might have been anticipated, at the conclusion of January 2024, Microsoft declared a commitment of $10 billion to the advancement of artificial intelligence. A few months ago, it would have been challenging to envisage the potential implications of this for us. It is possible that, in the near future, many people's imaginations may be transformed into tangible outcomes (Grandview Research, 2024). The field of artificial intelligence is progressing at a rapid pace. Notable corporations such as Google are engineering devices with artificial neural networks, which imitate the functionality of the human brain. Such a proposition would have been deemed implausible a few years ago. It will be of interest to observe the future development of AI (Gartner, 2024).

In order to address these challenges, there is a growing interest in integrating a range of emerging AI technologies, such as GenAI and machine learning (ML), into project management practices within the IT domain. GenAI comprises a variety of AI techniques that are capable of autonomously generating solutions, models or designs based on specified criteria and constraints. The potential benefits of this technology in IT projects include improvements in decision-making processes, optimisation of resource allocation and acceleration of development cycles. Despite the potential benefits, the integration of GenAI with IT project management methodologies remains relatively unexplored in the existing literature. Therefore, this study seeks to address this gap by investigating the feasibility and effectiveness of integrating GenAI with established project management practices in the context of IT. This article aims to provide valuable insights into the synergies between GenAI and project management in IT, thereby contributing to the advancement of both theoretical knowledge and practical applications in this area.

2.1. GenAI in Industry

GenAI represents a transformative innovation with applications across a range of industries, including healthcare, manufacturing, finance and logistics. By employing sophisticated machine learning methodologies, GenAI is capable of autonomously generating content, devising solutions, and conducting predictive analysis, thereby addressing intricate challenges in real-time (Hashfi, Raharjo, 2023). Such capabilities render GenAI a vital instrument for augmenting efficiency, curbing operational expenses, and facilitating innovative solutions (Bahai et al., 2024).

GenAI is particularly impactful in domains that require high degrees of adaptability and creativity. For example, it is widely employed in the fields of automated content generation, real-time data analysis, and scenario modelling, assisting businesses in navigating uncertainty and making data-driven decisions (Bodea et al., 2020; Hess, Kunz, 2024). The integration of GenAI with existing workflows frequently results in notable increases in productivity. This is evident in sectors such as healthcare, where it is employed in diagnostic imaging and drug discovery, and in finance, where it is utilized to enhance fraud detection and portfolio optimization.

Despite the considerable potential of GenAI, the adoption of this technology is often impeded by a number of factors, including technological challenges, ethical concerns and organisational resistance. It is emphasised in studies that these barriers must be addressed in order to fully capitalise on the benefits of GenAI in different domains (Bodea et al., 2020; Hess, Kunz, 2024).

2.2. IT Project Management

IT project management is inherently complex, necessitating the coordination of diverse teams, technologies, and resources to achieve project objectives within specified time and budget constraints. The traditional methodologies of the Waterfall and Agile models have long been regarded as the cornerstones of IT project management. While the Waterfall methodology places an emphasis on the completion of tasks in a sequential manner, the Agile approach emphasises iterative development, flexibility and the fostering of close collaboration with stakeholders (Hashfi, Raharjo, 2023).

However, these methodologies are constrained in their ability to effectively manage the increasing complexity and dynamism of modern IT projects. The management of cross-functional collaboration, the addressing of rapidly evolving requirements and the mitigation of risks in an effective manner represent significant challenges (Bodea et al., 2020; Hess, Kunz, 2024). The advent of new technologies has led to the emergence of tools that facilitate enhanced visibility and control over projects, including collaborative platforms and project management software. However, these tools frequently lack the sophisticated analytical capabilities necessary to optimise decision-making and resource allocation in real time.

The integration of AI into project management has provided a solution to some of these issues, facilitating predictive analysis, automated scheduling and enhanced risk assessment. Nevertheless, the integration of more advanced AI tools, such as GenAI, remains underexplored, particularly in terms of aligning these tools with established methodologies like Agile and Scrum (Hashfi, Raharjo, 2023).

2.3. Conjunction of GenAI and IT Project Management

The conjunction of GenAI and IT project management signifies a substantial leap forward in the resolution of the challenges inherent to contemporary projects. The capacity of GenAI to automate intricate processes, generate actionable insights and facilitate decision-making renders it particularly well-suited to the dynamic nature of IT projects (Bodea et al., 2020; Hess, Kunz, 2024).

The applications of GenAI in IT project management include:

- **Automation of tasks:** GenAI automates routine tasks, including the generation of reports, updates to schedules, and estimation of costs. This allows project managers to direct their attention to activities of a more strategic nature (Hashfi, Raharjo, 2023).
- **Enhanced collaboration:** is facilitated by NLP capabilities facilitate enhanced communication and alignment among project stakeholders by summarising meetings, generating real-time translations, and analysing stakeholder sentiment (Bodea et al., 2020).
- **Predictive analytics:** The application of predictive analytics enables the forecasting of future outcomes based on historical data. GenAI models facilitate enhanced risk assessment and decision-making by identifying patterns and predicting project outcomes based on historical data (Hashfi, Raharjo, 2023).

Nevertheless, the incorporation of GenAI into project management remains in its nascent stages. A review of the literature reveals significant gaps in knowledge, including a lack of empirical evidence on the long-term impacts of GenAI and the absence of structured frameworks for its implementation within traditional project management methodologies (Bodea et al., 2020; Bahai et al., 2024). Furthermore, ethical concerns pertaining to data privacy and algorithmic transparency remain pivotal challenges.

The reviewed literature evinces the considerable potential of GenAI to transform IT project management by augmenting efficiency, collaboration, and decision-making. Nevertheless, substantial gaps and challenges must be addressed to fully harness its capabilities. This study aims to bridge these gaps by investigating the practical applications of GenAI in IT project management, thereby providing actionable insights for researchers and practitioners.

3. Methodology

The case study approach was employed in this study to investigate the integration of GenAI in IT project management. The selection criteria were designed to encompass a diverse range of sectors within the IT industry, thereby ensuring a comprehensive perspective on the application of GenAI. The companies were selected based on their reported adoption of

AI technologies, demonstrated use of project management methodologies, and willingness to participate in the research. A purposive sampling strategy was employed to identify organisations with varying levels of AI integration, thereby ensuring representation of both early adopters and more established users of GenAI technologies (Górniak, 1998; Šmite et al., 2023).

3.1. Data Collection

A mixed-methods approach was employed for the collection of data, combining qualitative and quantitative methods in order to gain a comprehensive understanding of the implementation of GenAI in IT project management.

The companies selected for the interviews were chosen for specific reasons. Given the particular focus of the interview, organisations operating within the IT sector (including software development, IT system maintenance and related activities) were selected for inclusion. Ultimately, the interviews was completed by ten IT companies. The table (Table 1) provides a comprehensive overview with a snapshot and presentation of how they used GenAI and notable outcomes of the companies from which the case studies have been derived.

Table 1.
Company overview from the case studies

Company	Industry	GenAI Application	Notable Outcomes
Company 1	Software Development	Risk Management Optimization	Enhanced risk identification accuracy; proactive mitigation strategies
Company 2	IT Consulting	Resource Allocation Optimization	Reduced resource conflicts; improved workload distribution
Company 3	IT Solutions	Predictive Scheduling	Improved adherence to project timelines; minimized delays
Company 4	Software Development	Automated Quality Assurance	Reduced defect rates; faster release cycles
Company 5	Telecommunications	Task Automation	70% reduction in time for status reporting
Company 6	Financial Technology	Decision-Making Support	Informed decisions through real-time insights
Company 7	E-commerce	Stakeholder Communication	Streamlined updates; improved alignment
Company 8	IT Services	Resource Optimization	15% improvement in resource utilization
Company 9	Logistics	Predictive Analytics	20% improvement in on-time delivery rates
Company 10	Healthcare IT	Quality Assurance Automation	Enhanced product stability; increased customer satisfaction

Source: own study.

The primary data were gathered through semi-structured interviews with project managers, team leads, and IT professionals, thereby ensuring insights into both the strategic and operational levels. Furthermore, the interviews were supplemented by an analysis of project documents, stakeholder feedback, historical project data, and external databases. Use data analysis techniques to extract insights and patterns that can inform decision-making throughout the project lifecycle. The multi-source data collection was designed to enhance the validity and

reliability of the findings, as emphasised in prior research on effective research methods in dynamic organisational settings (Gałuszka et al., 2024; Stronczek, 2024).

3.2. Data Analysis

The data were subjected to thematic analysis in order to identify patterns and themes related to the application of GenAI in IT project management. A grounded theory approach was employed to identify insights emerging from the data, thereby enabling the formulation of a conceptual framework linking GenAI capabilities to project outcomes. Furthermore, quantitative data from project performance metrics were employed to triangulate qualitative findings, thereby ensuring a robust and comprehensive understanding of the phenomena under study.

To guarantee methodological rigour, tools such as Principal Component Analysis (PCA) were referenced for structuring multi-dimensional data, in accordance with methodologies employed in related studies on technology integration and organisational performance (Kowalska et al., 2024; Tomala, 2024). The study also employed techniques for validating data, including cross-validation between interview responses and document analysis, as recommended for high-credibility qualitative research in complex environments (Kaczmarek, 2024; Nycz-Wróbel, 2024).

4. Results

This chapter synthesises the insights from multiple case studies, offering a comprehensive overview of the application of GenAI in IT project management. These case studies, which encompass diverse contexts and organisational settings, provide invaluable insights and illustrate the practical utility of GenAI in addressing critical project management challenges. They not only highlight the benefits but also elucidate the constraints and implications of GenAI adoption in project processes.

4.1. Case Study Insights

The findings are classified into four principal categories, each exemplified by a distinct case study. This approach allows for a concentrated examination of the ways in which GenAI facilitates project management.

4.1.1. Risk Management Optimization

Objective: To evaluate the role of GenAI in enhancing risk management processes.

Methodology: A multinational software development company implemented GenAI-based predictive analytics tools with the objective of identifying and mitigating risks in a proactive manner. A machine learning model was constructed using historical project data, including risk

registers and performance metrics, with the objective of predicting and prioritising potential risks.

Results:

- Enhanced accuracy in identifying risks and predicting their impacts.
- Faster response times in addressing critical project threats.
- Improved allocation of resources to mitigate high-priority risks.

Implications: The case demonstrated that GenAI's predictive capabilities significantly improve risk management by enabling project managers to act proactively. However, challenges such as data quality and organizational readiness for AI adoption were identified, emphasizing the need for robust data governance and staff training.

4.1.2. Resource Allocation Optimization

Objective: To assess GenAI's ability to optimize resource allocation in IT projects.

Methodology: A large IT consulting firm applied GenAI algorithms to historical resource utilization data, employee skill profiles, and project schedules to dynamically allocate resources.

Results:

- Reduced resource conflicts and bottlenecks.
- Improved workload distribution and team productivity.
- Greater flexibility in adapting resource plans to changing project requirements.

Implications: The integration of GenAI enhanced project efficiency and throughput. However, concerns regarding algorithmic bias and transparency in resource allocation decisions underscore the need for ethical frameworks and validation processes in AI implementations.

4.1.3. Predictive Scheduling for Improved Timelines

Objective: To evaluate the effectiveness of GenAI in predicting and mitigating project scheduling conflicts.

Methodology: A leading IT solutions provider implemented GenAI-powered tools to analyze task dependencies, resource availability, and project milestones. Predictive scheduling tools anticipated delays and identified critical path activities.

Results:

- Improved project adherence to schedules.
- Proactive adjustments to resource allocations minimized delays.
- Insights into root causes of scheduling disruptions supported preventive measures.

Implications: GenAI demonstrated its value in enhancing project scheduling, reducing overruns, and improving stakeholder satisfaction. However, challenges related to data quality and the interpretability of machine learning models need further attention.

4.1.4. Automated Quality Assurance

Objective: To explore the use of GenAI in automating testing and quality assurance in software development projects.

Methodology: A software company utilized GenAI-powered tools to analyze code and identify potential defects early in the development cycle. Historical defect data and testing scripts informed machine learning models.

Results:

- Reduced defect rates and improved software reliability.
- Faster release cycles due to automated testing processes.
- Enhanced customer satisfaction with product quality.

Implications: The automation of quality assurance processes underscored GenAI's ability to streamline testing and improve software reliability. Nonetheless, the success of such implementations relies heavily on addressing infrastructure needs and ensuring organizational buy-in.

4.2. Synthesis of Insights

The integration of GenAI into project management processes across the case studies revealed several overarching themes:

- **Risk Management Enhancement:** GenAI's predictive analytics provide foresight into potential risks, enabling proactive mitigation and fostering resilience in projects.
- **Resource Allocation Optimization:** Dynamic algorithms minimize conflicts and ensure efficient use of resources, contributing to smoother project execution.
- **Scheduling Improvements:** Predictive tools enable the anticipation of delays and bottlenecks, resulting in timely adjustments that enhance delivery timelines.
- **Quality Assurance Advancements:** Automated testing powered by GenAI detects defects early and reduces post-release issues, accelerating time-to-market.

4.3. Challenges Identified

Although the case studies underscore the advantages of GenAI, they also draw attention to the considerable obstacles that remain. The availability of clean, unbiased, and comprehensive data remains a significant challenge, as the accuracy and reliability of GenAI models are contingent upon the quality of the input data. The ethical concerns associated with algorithmic decision-making, including the potential for bias and a lack of transparency, necessitate a significant focus on ensuring fairness and accountability in the deployment of GenAI systems. Organizational resistance to change, frequently rooted in skepticism about AI's capabilities or concerns about job displacement, can further impede the effective adoption of GenAI technologies. Additionally, the interpretability of GenAI models presents a challenge, as understanding and explaining their decision-making processes is essential for fostering trust among stakeholders and ensuring effective implementation in project management practices.

4.4. GenAI Tools in Project Management – examples of Tools using by the companies

There are already many AI-based project management tools and software available on the market. These tools use AI for different types of duties. While we can use many of them to streamline our project work, the excitement of artificial intelligence makes us equally eager to use its capabilities in our personal lives, and thus support ourselves with simple, tedious duties. In an era of digital transformation, the ability to use AI to optimize project management processes is becoming crucial. Below are some interesting implementations:

- **GPT Chat** - a basic tool you need to become friends with. This is the chat that started the whole storm about artificial intelligence November 2022. It will help us create descriptions for products, arrange schedules for both meetings and entire projects. It will make it easier to embrace creative brainstorming by summarizing the ideas that emerged during it. He can both group the conclusions and prioritize them. In turn, he will then answer emails according to the templates we give him in advance.
- **AIPRM for ChatGPT** - a browser plug-in will help with the above tasks, giving us access to the commands we use to communicate with chat, written by other users. In the context of tasks for project management, four categories are worth noting: Plan, Script Writing, Spreadsheets, Summarize. The "Script Writing" category fits perfectly into the growing "no code" trend. AI allows you to successfully develop rules for Excel, write appropriate macros, and also finds its way well into Google Apps Script or JavaScript. People who don't have much exposure to programming languages on a daily basis can try to automate certain parts of their work this way.
- **Gist/Claude** - creates notes and extended summaries from meetings, being a useful tool for meeting participants and those returning to work after a vacation, are add-ons for Slack that write meeting notes and extended summaries. This functionality is useful for both the meeting participants themselves and for people who are returning to work after a vacation.
- **Tome** - a still fledgling tool for semi-automatic creation of presentations.
- **Compose AI** - makes it easier to write back emails.
- **Otter AI** - prepares transcription of recordings and summaries of meetings in Microsoft Teams.
- **Browse AI** - allows you to program a robot that collects data from defined web pages and monitors changes on those pages.

4.5. Prompting in project management: an examination of the ways in which companies use it

In the field of project management, the concept of "prompting" harnesses the power of artificial intelligence to streamline and increase the efficiency of various project activities. A prompt, in this context, acts as a specific instruction or input given to an AI system, which

then generates tasks, decisions or content relevant to project management needs. This section illustrates how AI-based prompts can significantly optimize the creation and tracking of task lists, the assignment of responsibilities to team members, and the overall coordination of project schedules and goals. Using precise prompting, project managers can ensure more structured, efficient and proactive management processes, thereby increasing the productivity and success of their projects. Examples of their use are shown below, along with an example of prompts in project management.

4.5.1. Generating task lists and prioritizing work

AI can be used to create comprehensive task lists for projects, helping project managers organize work and prioritize tasks based on factors such as urgency, importance and dependencies. By providing AI with information about the project, it can generate a list of tasks that need to be completed, allowing project managers to easily track work and make sure nothing gets missed.

Prompt example: *Identify potential bottlenecks in the following project tasks: user research, modelling, design, development, testing and deployment.*

4.5.2. Assign tasks to team members with clear instructions

Project managers can use AI to create clear and concise tasks for team members. By inputting the necessary information and desired outcomes, AI can generate task descriptions with specific instructions, making it easier for team members to understand their responsibilities and expectations.

Prompt example: *Write instructions for a developer to implement a user authentication function in our web application.*

4.5.3. Track progress on tasks and ensure deadlines are met

AI can help project managers track task progress and ensure deadlines are met. By using AI to generate progress reports, project managers can easily monitor the status of tasks and identify potential issues before they become critical. This allows project managers to proactively address any issues and keep projects on track.

Prompt example: *Provide a list of tasks that are at risk of missing deadlines and suggest possible solutions to get them back on track.*

4.5.4. Using AI to create meeting agendas and minutes

Project managers can use AI to create meeting agendas and record detailed minutes, ensuring all team members are on the same page and meetings are productive. By providing AI with meeting information and objectives, it can generate well-structured agendas and comprehensive minutes, helping project managers maintain clear communication and documentation.

Prompt example: *Transform the following meeting notes into a well-structured set of minutes: budget approved, deadline extended, new team member assigned and additional resources allocated.*

4.5.5. Using AI to brainstorm and gather team feedback

Project managers can also use AI to facilitate brainstorming sessions and gather feedback from team members. By providing AI with a specific topic, it can generate a list of ideas or discussion points, helping project managers create a more diverse and inclusive environment for generating ideas.

Prompt example: *Come up with ideas to increase team engagement and motivation during a long-term project.*

4.5.6. Identify potential risks and mitigation strategies

AI can help identify potential risks and develop mitigation strategies for projects. By providing AI with information and project context, it can generate a list of potential risks and suggest strategies to address them, helping project managers to proactively manage potential challenges.

Prompt example: *Analyze the potential challenges of implementing a new project management tool on our team and offer recommended ways to overcome them*.

4.5.7. Create engaging team building activities

Project managers can use AI to come up with engaging and creative team building activities that foster collaboration and camaraderie among team members. By providing AI with information about a team's size, interests and goals, it can generate ideas about team building tailored to specific needs.

Prompt example: *Suggest five integration activities suitable for a team of developers working remotely.*

4.5.8. Generating user stories and acceptance criteria

AI can help project managers in Agile environments generate user stories and their respective acceptance criteria. By providing information about project goals and user requirements, AI can create user stories that align with project goals and define the criteria needed to ensure their functionality meets user expectations.

Prompt example: *Generate acceptance criteria for a user story related to the implementation of a secure login feature for an online banking application.*

4.5.9. Documenting project requirements and changes

Artificial intelligence can be a helpful tool in documenting project requirements and tracking any changes to scope or objectives. This helps to ensure that project documentation remains accurate, up-to-date and accessible to all stakeholders.

Prompt example: *Develop a project requirements document for our new application, including functional and non-functional requirements.*

4.6. Conclusion

The findings from these case studies demonstrate the tangible benefits of integrating GenAI into IT project management, such as improved efficiency, reduced costs, and enhanced project outcomes. However, they also point to challenges that need to be addressed to maximize its value. Future research should focus on refining GenAI applications, developing best practices, and exploring new areas of integration to fully realize its potential in revolutionizing project management processes.

5. Discussion

This study demonstrates the considerable impact that GenAI can have on IT project management. It illustrates the capacity of GenAI to optimise processes, enhance decision-making and improve collaboration among stakeholders. The findings demonstrate how GenAI tools, such as predictive scheduling and resource allocation algorithms, facilitate more efficient project management in organisations, whilst addressing long-standing challenges such as resource conflicts, scheduling delays and risk management.

The capacity of GenAI to analyse extensive datasets and generate actionable insights is especially beneficial in the context of managing the complexities inherent to IT projects. To illustrate, the predictive capabilities of GenAI permit project teams to anticipate potential risks and address them in a proactive manner, thereby enhancing project resilience and stakeholder satisfaction. Similarly, the deployment of GenAI for the automation of repetitive tasks, such as reporting and quality assurance, has the effect of reducing the manual workloads of project managers, thereby enabling them to focus on strategic priorities.

Nevertheless, the study also uncovers significant obstacles to the successful implementation of GenAI. The quality and availability of data remain significant concerns, as the efficacy of AI-driven tools is contingent upon the integrity and comprehensiveness of the datasets upon which they rely. The necessity for robust frameworks to ensure fairness and accountability is underscored by ethical challenges, including those pertaining to algorithmic bias and the lack of transparency in decision-making processes. Furthermore, organisational resistance, driven by scepticism or concerns about job displacement, serves to further complicate integration efforts. Furthermore, the interpretability of GenAI models remains a significant challenge. In order to build trust and confidence, stakeholders require clear explanations of AI-driven decisions.

In order to address these challenges, organisations should develop and implement ethical AI frameworks with the aim of mitigating the risks associated with bias and transparency. It is similarly crucial to invest in training and capacity-building programmes, with the objective

of equipping project teams with the requisite skills to utilise GenAI tools effectively. The implementation of incremental adoption, commencing with pilot projects, enables organisations to refine their strategies, cultivate expertise and identify potential impediments prior to the comprehensive deployment of GenAI.

This study makes a contribution to the theoretical discourse on GenAI in IT project management by providing empirical evidence on its applications and effectiveness. Furthermore, the study identifies shortcomings in existing research, including the necessity for investigations into the long-term consequences of GenAI, sector-specific applications, and hybrid methodologies that integrate traditional project management frameworks with AI-driven tools.

It is recommended that future research explore these areas while addressing the ethical and social implications of GenAI adoption. By addressing these challenges and building on the insights provided, organisations can unlock the full potential of GenAI, leading to innovative, efficient, and ethical project management practices. This study offers a foundation for such advancements, emphasising the need for continuous exploration and adaptation in the integration of AI technologies in project management.

6. Summary

This study illuminates the potential for transformative change in the field of IT project management through the application of GenAI, drawing insights from case studies conducted in ten IT companies. The findings demonstrate that GenAI has the capacity to enhance project outcomes in a number of ways. Firstly, it can automate routine tasks, thereby freeing up time and resources for more complex tasks. Secondly, it can optimise resource allocation, ensuring that the right resources are allocated to the right tasks at the right time. Thirdly, it can improve risk management, allowing for more informed decision-making and the mitigation of potential risks. Finally, it can streamline scheduling processes, reducing the time required for planning and execution. To illustrate, the predictive analytics capabilities of GenAI facilitated more effective risk identification and mitigation, whereas its resource optimisation algorithms alleviated congestion and enhanced team productivity. Notwithstanding these successes, challenges such as data quality, algorithmic bias, and organisational resistance were evident, underscoring the necessity for robust frameworks and best practices for integration.

Further research is required to investigate the long-term effects of GenAI on project success, organisational dynamics and team collaboration. It would be beneficial for future studies to investigate the sector-specific applications of this technology, as well as its ethical implications and potential for integration with traditional project management methodologies, such as Agile

and Scrum. Furthermore, research is required to develop effective skill-building initiatives for project teams to utilise GenAI effectively.

It should be noted that this study is not without limitations. Firstly, the focus on ten IT companies may not fully represent broader organisational contexts. Secondly, the emphasis on short-term impacts over long-term outcomes may not fully capture the full scope of the study. The rapid evolution of AI technologies also presents a challenge in maintaining the currency of findings. Nevertheless, this research offers valuable insights into the practical applications of GenAI in IT project management and establishes a foundation for further investigation, addressing critical challenges and fully elucidating its potential.

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SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

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THE IMPACT OF ACCOUNTING ON THE MANAGEMENT OF A NATIONAL PARK

Beata PATER

University of Agriculture in Krakow; beata.pater@urk.edu.pl, ORCID: 0000-0003-4209-241X

Purpose: The aim of the paper is to present the nature of national park management in Poland and to indicate the influence of accounting on national park management**.**
Design/methodology/approach: The research methodology is based on the analysis of legal acts concerning the functioning of national parks, the analysis of accounting literature and the analysis of financial statements and reports on the implementation of financial plans of national parks in Poland.
Findings: The lack of consistency in accounting policy makes the operation of the parks, including their financial management, less transparent. This is contrary to the need to ensure transparency in public finances. Therefore, it seems necessary to establish a uniform accounting policy and chart of accounts for national parks. Of course, in such a model chart of accounts, parks could expand the scope of independent analysis by introducing more detailed horizontal and vertical divisions of accounts, while maintaining the uniformity and comparability of accounting information.
Originality/value: The publication discusses issues related to the organisation of the accounting system in national parks in Poland. The subject is important in the context of ensuring transparency in public finances and the possibility of comparison, especially of the costs incurred for the implementation of the tasks entrusted to the national parks in Poland.
Keywords: national park, national park accounting, accounting policy, national park management.
Category of the paper: Research paper.

1. Introduction

National parks are organisations entrusted with a special task – the protection of biodiversity and landscape in the most beautiful and valuable natural areas. In recent years, significant changes have taken place in their organisation, legal form and financing rules. In place of national parks – budget units, state legal entities were established, which are obliged to protect both animate and inanimate nature, and at the same time are obliged to take care of its financing by conducting specific economic activities limited by the obligation to protect this nature (Pater,

2018, 2020). The greatest consequence of the change in the legal form, from the point of view of accounting for national parks, is the transition from the budget accounting system, which is based on the cash basis, to accounting in the income and cost (accrual) system. There is an exception to that rule, such as the settlement of budget subsidies in the cash system and planning both on a cash basis and on an accrual basis. The documents that since 2012 have been provided by the national park to the minister responsible for the environment, who is to supervise its activities and control it, include primarily: financial statements, reports on the implementation of the financial plan, reports on the implementation of subsidies, as well as other ad hoc reports or reports about the national park.

The role of national parks in preserving biodiversity, their importance for society and descendants, as well as the affiliation of national parks to public finance sector entities make managing these organisations a challenge for their directors. Managing a national park, like any economic entity, requires planning, organising, leading and controlling. Among the numerous tools that organisations have at their disposal to best fulfill these functions, there is also accounting.

The aim of the work is to present the nature of managing national parks in Poland and to indicate the impact of accounting on managing a national park. In order to achieve this goal, an analysis of legal acts concerning the functioning of national parks, an analysis of accounting literature and an analysis of financial statements and reports on the implementation of financial plans of national parks in Poland were used.

2. Legal and organisational conditions for managing a national park

The protection of natural resources is global in nature, which is why it is dealt with by international organisations, and is subject to international agreements and conventions. This results from the need to protect biodiversity. Legal protection fulfills this task best. Nature all over the world, including Poland, is protected due to systemic solutions, through the creation of protected areas (national parks, nature reserves, landscape parks, "Natura 2000" areas, protected landscape areas), species protection and individual protection, including natural monuments, documentation sites, ecological sites, nature and landscape complexes (Article 6 of the Act of 16 April 2004 on Nature Conservation. Journal of Laws 2004, No. 92, item 880). Territories covered by various forms of protection occupy a total of 32.3% of Poland's area, most of which are protected landscape areas with a relatively low protection regime. National parks cover a total area of 315.2 thousand ha, constituting only 1% of the country's area. The structure of the parks' area is dominated by forest land (63% of the area), agricultural land constitutes 15% of their area, and water 6% (GUS, 2023).

Currently, there are 23 national parks in Poland. The Act of 16 April 2004 on Nature Conservation (Journal of Laws 2004, No. 92, item 880, art. 8, section 2) defines a national park as an area distinguished by special natural, scientific, social, cultural and educational values, with an area of no less than 1000 ha, in which all nature and landscape values are protected. National parks, as an organisation protecting nature, ensure the implementation of tasks imposed on them by the legislator. A national park is therefore established in order to preserve biological diversity, resources, formations and components of inanimate nature and landscape values, as well as to restore the proper state of resources and components of nature and to recreate distorted natural habitats, habitats of plants, animals or fungi.

In a national park, the most important thing are the natural resources and therefore the proper protection of the ecosystems. This does not mean that their use should be abandoned. They have been entrusted to national parks to protect them and to use these resources wisely, in accordance with the concept of sustainable development as defined by Brundtland, i.e. meeting the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1989; Nasza wspólna przyszłość, 1991).

Nature conservation activities should be planned, which is why the Nature Conservation Act requires national parks to prepare a conservation plan, which is prepared individually for each park. However, until the plans are prepared, the way conservation activities are carried out is described in conservation tasks. These are documents that identify existing and potential threats to the park's ecosystems and describe methods to reduce or eliminate them. The document also identifies areas of the park under strict, active or landscape protection. It specifies the method of active protection of ecosystems, together with the size, type and location for the tasks described. The process of drawing up protection plans is time-consuming and complex. Under the current law, national parks had until 15 November 2018 to do so. According to the post-audit information, in more than half of the national parks, the conservation tasks have been defined in regulations issued by the Minister of the Climate and Environment, not in protection plans, even though the deadline for their preparation has passed. To date, 11 national parks have approved conservation plans. This means that not all national parks have documents setting out specific conservation objectives for the park and its natural assets. Draft protection plans that have already been submitted to the Ministry of the Climate and Environment have been under evaluation for almost 10 years, despite the fact that Article 19(5) of the Nature Conservation Act sets a deadline of 6 months (NIK, 2024).

The area of a national park includes land with different ownership structures - both state and private. It is extremely important for the nature of a national park and for the management of such an organiation that its territory is accessible. A national park can be accessible for the following purposes: scientific, educational, tourist, recreational, sporting, which is in line with the objectives of the Nature Conservation Act.

Tourist traffic in parks, in addition to its many benefits for each visitor, brings a great threat to the nature of national parks (Ćwiek, Pater, 2020). In 2022, 16 million people visited national parks in Poland, while in 2023 it was 15.5 million tourists (GUS, 2023, 2024). The Nature Conservation Act contains a list of restrictions that must be respected by visitors, and the park director sets the access policy for national park by means of a regulation. Among other things, these regulations determine the number of people who can visit a site at the same time and the amount of the entrance fee to the national park. It is the director's duty to ensure the safety of visitors, which includes the provision and maintenance of appropriate tourist infrastructure. Educational activities also require appropriate infrastructure, such as museums, nature trails or classrooms. In this way, the need to educate the public about nature and how to enjoy its richnes in accordance with the principles of sustainable development is met.

Parks perform a number of socially useful functions: firstly, they are created to protect natural resources, but within this overarching function they also perform scientific, didactic, historical and cultural, tourist and recreational functions, as well as an economic function. The latter can be understood in two ways: as a business entity and as part of the economic system at regional and state level.

A park is not only a form of area-based nature conservation, but also an organisational unit, which has its own structure and functions according to rules set out in the Act. Pursuant to Article 8(1) of the Public Finance Act of 27 August 2009 (Journal of Laws 2009, No. 157, item 1240), national parks are created in forms specified by law. In 2012, national parks gained legal personality by changing their legal form from unincorporated state budgetary units to a state legal person. Pursuant to Article 9(14) of the Public Finance Act of 27 August 2009, the public finance sector is co-created by state legal persons established under other acts in order to perform public tasks, excluding enterprises, research institutes, banks and commercial law companies.

Therefore, in accordance with the regulation of article 8a, paragraph 1 of the Act of 16 April 2004 on Nature Conservation, a national park is a legal entity within the meaning of article 9, item. 14 of the Act of 27 August 2009 on public finance, in relation to which it can be the subject of civil law relations.

The basic legal act regulating the operation of national parks in Poland is the Nature Conservation Act. According to article 10(2) of the Public Finance Act, the regulations of the Public Finance Act apply to state legal entities operating on the basis of separate legal acts, which constitute the basis for their establishment, so that in the case of a conflict of regulations, the principle of lex specialis derogat legi generali can be applied - a law with a higher degree of specificity should be applied before a more general law, which in this case allows us to conclude that the Nature Conservation Act takes precedence over the Public Finance Act. It should be noted that, due to the complexity of the legal issues related to national parks, the Nature Protection Act also refers to other laws.

Parks operate on the basis of their statutes, which are granted by way of an ordinance by the minister responsible for the environment. The statutes define the internal structure of the park, the functioning of its authority and the way in which powers are delegated to ensure the proper functioning of the national park and the fulfilment of its tasks. The internal organisation of a national park is defined in detail in the organisational regulations, which are issued by decree of the park director, and the statutes provide a framework for the internal organisation of the park.

National parks are equipped with the necessary material resources (natural resources, buildings, structures, infrastructure, means of transport, machinery and other necessary equipment), organisational resources (employees, organisational structure) and financial resources, i.e. revenues generated by the park in connection with providing access to tourist attractions and the area of the national park, as well as educational activities, sale of timber from reforestation, timber after natural disasters and from cultivation treatments (in national parks there is no forest management as understood in commercial forests) and other revenues listed in the Nature Conservation Act (Art. 8 h), including a subsidy from the state budget. The property of the national park is wholly owned by the state. The method of management is based on self-financing, i.e. the costs of carrying out the activities of the National Park, including the fulfilment of its tasks, are covered by its revenues. The catalogue of costs and revenues is precisely defined in the article 8h of the Nature Conservation Act.

The specificity of national park management is influenced by many factors, but what distinguishes the management of a national park from the management of other entities is the legislation that regulates in detail the various areas of management of such an organisation. This is because parks subordinate all actions and decisions to the need and priority of nature conservation.

It is also very important to note that national parks in Poland are very diverse entities in terms of attractiveness for tourists, natural resources, location, accessibility, the amount of the budget they have at their disposal, including the amount of subsidies from the state budget, the amount of revenue generated from their business activities and, of course, the size of the organisation itself - as parks in Poland employ from a few to more than 100 people (Pater, 2020).

3. Accounting in the management of national parks

A national park, not only as an economic entity with legal personality, but also as a public institution, has an obligation to properly document its activities, and the information it collects should become the basis for reasoned decision-making.

In this respect, the accounting system, i.e. the information system of an economic entity, performs the functions of identification, measurement, collection and processing of data. On this basis, it is possible to analyse and evaluate phenomena and management processes in the organisation. It has an important, even key role to fulfil in an entity. It also communicates financial information to interested users (Nowak, 2011). In other words, it supports management functions. In performing these functions, accounting identifies, measures, collects and processes data, analyses and evaluates economic phenomena and processes. The accounting system in national parks is used to record economic operations, provide data for analysis and evaluation of the organisation's activities and for the day-to-day management needs of the entity (Czubakowska et al., 2006). In practice, accounting is a set of techniques and methods for measuring and communicating economic information in such a way that various stakeholders and managers can make valid, rational judgements in the decision-making process (Dobija, 1999).

The amount of information generated in the accounting system of the national parks has been greatly affected by the changes that took place in 2012, when the national parks were transformed from budgetary units to state legal entities. The changes experienced by the parks at that time also affected their accounting, as they were obliged to fully comply with the regulations of the Accounting Act of 29 September 1994. Journal of Laws of 1994, No. 121, item 591. As budget units, the parks kept accounts mainly for the purpose of settling accounts with the state budget. This change therefore brought new obligations, but also opened up the possibility of collecting data to produce information for management purposes. Such solutions support the proper fulfilment of the tasks of any organisation, so national parks can also benefit from them, especially as they are entities with very specific functional characteristics.

Table 1.
The Structure of the Income of the selected national parks in the Malopolska for the Years 2019-2022

National park	Year	State budget subsidies	Own revenue	Other
		W %		
Pieninski	2019	35.4	48.4	16.2
	2020	37.5	42.1	20.4
	2021	29.2	52.7	18.1
	2022	39.4	50.3	10.3
Ojcowski	2019	44.9	40.6	14.5
	2020	53.6	24.1	22.3
	2021	37.9	48.5	13.6
	2022	47.0	37.5	15.5
Gorczanski	2019	59.7	9.0	31.3
	2020	62.3	5.9	31.8
	2021	62.6	9.8	27.6
	2022	62.6	8.6	28.8
Tatrzanski	2019	16.0	62.3	21.6
	2020	13.4	67.8	18.8
	2021	7.9	71.7	20.4
	2022	9.4	74.5	16.2

Source: own work based on the financial reports of the national parks.

The change in the legal form and the fact that the national parks are engaged in economic activities allows them to retain the income generated and use it for nature conservation purposes. The share of funds from the state budget varied, ranging from 9% in the Tatra National Park to 79% in the Bory Tucholskie National Park in 2022 (Financial Reports of the National Parks for 2022). In the national parks of Malopolska region, the revenue structure also varied. National Parks: Tatrzanski and Pieninski, generated a larger share of revenues from their activities, while in Ojcowski and especially Gorczanski National Park the budget subsidy significantly contributed to the revenue structure (Table 1).

The Nature Conservation Act has also introduced the possibility of taking loans and credits, which can only be done by administrative decision, with the consent of the Minister of the Environment in agreement with the Minister of Finance. A national park can take loans and credits for the implementation of tasks up to 60% of the costs or the amounts included in the financial plan of revenues. Thus, the national park, as a legal entity of the state, conducts an independent financial management and covers the expenses for financing the tasks specified in the law, including the tasks of the national park service, and the costs of its activities from its funds and earned income.

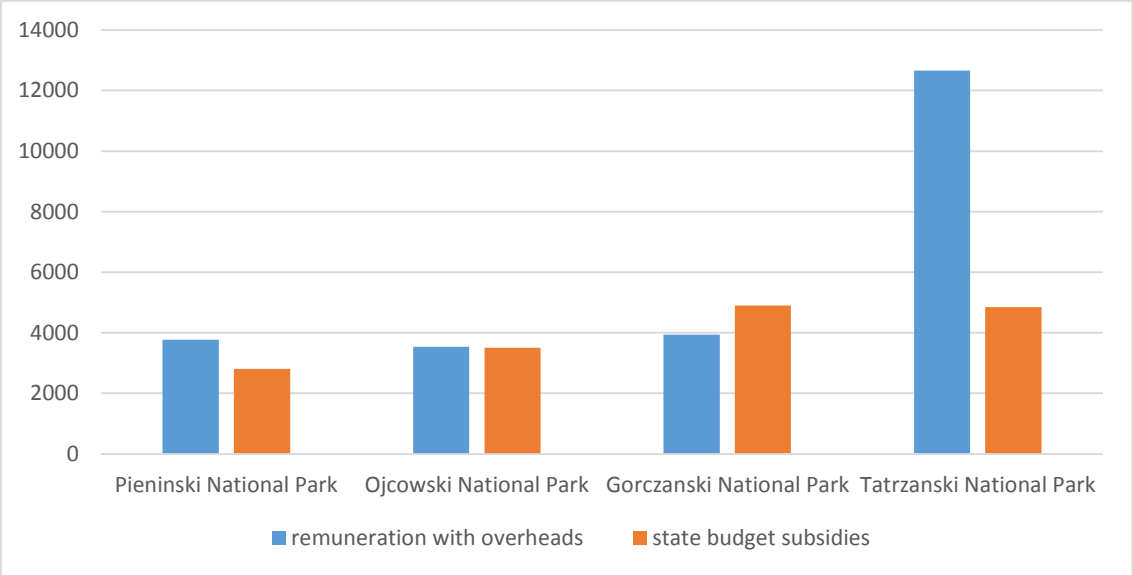

Figure 1. Comparison of the level of salaries with the level of budget subsidies for 2019-2022 in selected national parks in Malopolska - average values in thousands of PLN.

Source: own work based on the financial reports of the national parks.

A major cost in park budgets is the cost of remuneration with overheads. In the most parks, the subsidy from the state budget does not even cover these costs, which means that the implementation of the basic tasks of the park is financed with funds generated by the business activity or obtained from external sources. Such a situation can lead to delays in the implementation of conservation plans and tasks. In this regard, the situation in the selected national parks does not differ from the situation in parks all over Poland. Among the selected parks, only the budget subsidy for the Gorce Park covered remuneration with overhead costs.

In the Tatra National Park, on the other hand, the budget subsidy covered about 40% of the cost of remuneration with overheads (Figure 1).

The basis of the Park`s activities is an annual financial plan, which is prepared in a task-based manner for the budget year and the following two years. Such a draft of the financial plan of a state legal entity is submitted to the Minister of Finance in accordance with the procedure and within the term established by the regulations on work on the draft of the budget. The financial plan, as well as the financial plan in the task-based system, is prepared both on a cash basis (recording only realised revenues and expenses) and on an accrual basis, recording all earned revenues accruing to the entity and costs charged to it in connection with such revenues for a given financial year (Kiziukiewicz, 2014).

National parks, when accounting for the subsidy received from the state budget, are obliged to provide information taking into account the cash basis, and as state legal entities they should conduct financial management on an accrual basis (Winiarska, 2012). Despite the change in legal form, no obligation to standardise accounting policy has been introduced, nor has a model chart of accounts been developed. Each of the 23 national parks has shaped its accounting system autonomously.

The information on the finances of the national parks and their detail is derived from the way in which the national parks keep their accounts. The chart of accounts, which is a systematic list of accounts with their names and symbols used to organise the recording of economic events, is important in this aspect. The layout of the chart of accounts is not the same for each of the parks, although it is clear that in each of the national parks the accounts are kept in accordance with the regulations of the Accounting Act. In addition, the *Regulations on the detailed manner of conducting the financial management of the national park* (Rozporządzenie Rady Ministrow, 2012) do not provide any guidelines for the accounting policy. As a result, it is difficult to compare the financial data of the national parks, primarily costs. As mentioned above, the accounting of national parks is based on the accrual method and the profit and loss account is prepared on a comparative basis. The accounting of the national parks as budgetary units was based on the cash method. At that time, particularly in terms of reporting, little attention was paid to costs in the parks' charts of accounts, which generally confined themselves to recording costs by nature.

In the current legal form, costs are also reported by nature, which means that the financial statements only provide information on the nature of costs incurred. In the accounting of the national parks, the accounts related to the tasks performed by the parks have been separated, but only for the purpose of preparing reports on the implementation of the financial plan in a task-based arrangement and preparing reports on the implementation of the annual financial plan in the arrangement compliant with the Public Finance Act for state legal entities, in which the operating costs and the costs of task performance are shown. However, the management of national parks should take place both at the level of an individual park and at the level of the whole group of national parks. It would therefore be useful to have a reliable assessment of the

individual tasks in each national park. Financial plans make possible to compare between individual parks in terms of their general costs, whereas task-based planning does not. This is because national parks plan and report their activities as a single task (Revenues and costs of national parks are realised in the following task system: State function 12 Environment, task 12.1 W Shaping biodiversity, subtask 12.1.1 W Nature and landscape protection, activity 12.1.1.2 W National parks).

As a consequence of the lack of legal norms regarding the necessity of reporting on the costs of individual tasks of the national parks, the way in which they are recorded varies greatly. From the information gathered in the course of the research, it is clear that the layout of the accounts in Unit 5 is very different. As a result, it is not possible to extract comparable information about where costs are incurred. The weak point here is the lack of a consistent accounting policy. As a result, it is virtually impossible to obtain information on the costs of individual tasks of the national parks, e.g. the costs of providing access, the costs of carrying out research, the costs of education, the costs of nature conservation tasks, etc. The method of accounting used by the national parks is not uniform. The present way of accounting in the national parks does not allow cost comparisons to be made, even with regard to the three main tasks of the national parks, i.e. nature conservation, access and education. These cannot be derived from the financial reports. Although in the majority of parks records are kept that make it possible to separate the costs of nature conservation, provision, education, research and nature monitoring, salaries and administrative costs, there are also parks where the costs of the tasks are divided differently, i.e. into costs related to education, nature conservation and providing access. In a report by Babczuk & Kachniarz (2015), carried out and financed at the request of the Association of Employers of Polish National Parks, the authors admittedly carried out an analysis of the survey data received on the level of costs of tasks performed, but they also confirm that their comparability between parks is not entirely possible. For example, the maintenance of forester's lodges is treated as an administrative cost in some parks and as a conservation cost in others. There are more such discrepancies as a result of the different accounting policies adopted by the national parks.

4. Conclusions

Accounting as an information system within an organisation can provide information not only for reporting but also for management purposes. A uniform accounting policy is essential for analysing the economic situation of parks and for making comparisons between them. Of particular importance is cost accounting, which in its current form does not provide a means of understanding the costs of the functions performed and making reliable comparisons between parks. The lack of consistency in the accounting policy makes the picture of the functioning of

the parks, including their financial management, not very transparent, which is contrary to the need for transparency in public finances.

Therefore, the establishment of a uniform chart of accounts for national parks, together with the establishment of a model and uniform accounting policy, becomes indispensable. Of course, in such a model chart of accounts, parks could expand the scope of independent analysis by introducing more detailed horizontal and vertical divisions of accounts, while maintaining the uniformity and comparability of information coming from the accounting system. In addition, the information from the financial and accounting system should be useful not only from a financial accounting perspective, but also from a management accounting perspective. Based on the observation of the way accounting works in these companies, the conclusion is that managers underestimate the role of financial information and the accounting system and do not realise how much useful information for management they could obtain by implementing solutions developed within the framework of management accounting as well as financial accounting. This may be due to a conservative approach aimed solely at fulfilling legal obligations. Of course, these are public institutions, so costly solutions should not be introduced. However, consideration could be given to introducing a uniform way of recording costs, as cost accounting tailored to the activities carried out provides the knowledge to effectively manage not only a single park, but its entire system.

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SUSTAINABLE COMPETENCIES: TERMINOLOGY, CLASSIFICATION AND BIBLIOMETRICS

Katarzyna PIWOWAR-SULEJ[1*], Agata AUSTEN[2]

[1] Wroclaw University of Economics and Business; katarzyna.piwowar-sulej@ue.wroc.pl, ORCID: 0000-0002-4627-4344
[2] University of Economics in Katowice; agata.austen@uekat.pl, ORCID: 0000-0002-1362-2736
* Correspondence author

Purpose: The article aims to respond the following questions: 1) What are sustainable competencies? What are the components of these competencies? 2) What does the science map for sustainable competencies look like?
Design/methodology/approach: The article utilizes the narrative and bibliometric review methods of papers on sustainable competencies, indexed in the Scopus database.
Findings: The authors identified different approaches to the analyzed competencies. They proposed a division of sustainable competencies, taking into account different professional groups. They showed that the greatest research attention has so far been focused on higher education for sustainable development. There is a paucity of research on practices undertaken by employers as part of human resource development.
Research limitations/implications: This research is limited to literature indexed in the Scopus database.
Practical implications: This article educates readers about the role of sustainable competencies in today's working world. It can help them to better understand what skills are crucial for their career success. Giving concrete examples of sustainable competencies and their role in different professional fields can provide practical guidance for people who are looking for career development tips. Furthermore, the article shows how – i.e., through the use of sustainable competencies – employees can contribute to social and environmental progress.
Social implications: By highlighting the importance of sustainable competencies, the paper contributes to a broader understanding and adoption of sustainability practices, ultimately leading to more sustainable societies.
Originality/value: This is the first review on sustainable competencies. A division of these competencies into those required from all employees and those represented by sustainability specialists (including representatives of so-called green jobs) is proposed. The authors also formulated future research directions.
Keywords: sustainable competencies, definitions, typology, green jobs, science mapping.
Category of the paper: Literature review.

1. Introduction

Over the last few years, the topic of sustainability has gained enormous popularity worldwide. Increased public awareness of the impact of human activity on the environment, climate change, and the need for sustainable resource management has made sustainability a key area of interest for society, companies and institutions at various levels (Piwowar-Sulej, 2022a). Social needs have also gained in importance, which, alongside economic and environmental needs, is one of the three pillars of sustainable development (Elkington, 2004).

According to Jonker et al. (2011), companies have a high capacity to react quickly to existing problems and implement corresponding changes. Therefore, their role in achieving the Sustainable Development Goals at national or international level cannot be overestimated. This has given rise to the concept of organizational sustainability, which promotes management that simultaneously and equivalently takes into account economic, social and environmental issues related to the functioning of a company (Dyllick, Hockerts, 2002). Moreover, the concept of sustainable human resource management (HRM) has also emerged, which incorporates business, social and environmental aspects in the management of people. Its main objective is to create a harmonized approach that contributes to a balance between organizational effectiveness, employee satisfaction, as well as social and environmental values (cf. Ehnert, 2009). One of the main activities of sustainable HRM is the development of human resources, which is part of the company's long-term growth orientation (Piwowar-Sulej, 2022b). Indeed, no concept can be implemented effectively without a properly prepared workforce. In this connection, the need to provide organizations with so-called sustainable competencies (competencies in sustainability, competencies for sustainability/sustainable development, sustainability competencies) is exposed (Piwowar-Sulej, 2023).

Sustainable competencies are becoming increasingly important in today's dynamic business environment. Furthermore, society is becoming increasingly aware of sustainability issues. It is therefore important to provide an understanding of what competencies are and will be important in the long term, not only for the development of individual careers, but also for society as a whole. It is also worthwhile to analyze the existing body of knowledge devoted to these competencies in an objective and reproducible way. Therefore, the aim of the article was set to answer the following questions:

1) What are sustainable competencies? What are the components of these competencies?

2) What does the science map for sustainable competencies look like?

The first part of the article – to answer the first question – uses a narrative literature review. In turn, the second part of the article uses science mapping which is a bibliometric data analysis technique that helps to understand the structure and dynamics of scientific knowledge, to identify research trends, and to assess the impact of specific studies or scientific areas (Chen et al., 2015). This was carried out using the Scopus database of scientific publications.

2. Sustainable competencies: their scope and justification of the need for shaping them across groups of employees

Competencies for sustainable development have been broadly defined as a combined set of knowledge, skills, attitudes and values that enable effective global action on real-world sustainability issues, challenges and opportunities, according to the context (Brundiers et al., 2021). On the one hand, these competencies will form the basis for certain professions - commonly referred to as "green jobs" (Sulich et al., 2020). These professions of the future will make a significant contribution to the successful transformation of organizations towards sustainability, focusing primarily on the businesses' environmental goals. However, on the other hand, according to the definition presented in the introduction of the article, sustainability is not only about protecting the environment. The literature advocates, for example, the implementation of so-called frugal innovation, which refers to the development and implementation of new products, services or processes that are both economical and environmentally friendly. These innovations are usually focused on creating low-cost solutions that meet specific needs, especially in areas with limited financial resources. They are characterized by simplicity and efficiency (Iqbal, Piwowar-Sulej, 2023). Thus, sustainable competencies are needed for the engineers designing these processes and products.

Table 1 presents a selection of approaches to sets of competencies for sustainable development. Analyzing the presented competencies, the following common competencies can be observed:

1. Systems thinking – indicating the importance of understanding interconnected systems for sustainable development.
2. Anticipatory/future thinking – highlighting the need for proactive and forward-thinking approaches.
3. Normative competencies – emphasizing the ethical dimensions of decision-making.
4. Interpersonal competence – reflecting the recognition that interpersonal skills are crucial for collaboration, effective communication, and teamwork in the context of sustainable development.

Sustainability-related industries such as renewable energy and green technology have been and will continue to be a major source of green job creation. However, on 5 January 2023, the European Parliament's Corporate Sustainability Reporting Directive came into force and the first entities were obliged to report under it in 2025. Poland - as an EU member state - is obliged to transpose the provisions of the directive into national law by 6 July 2024. The directive expands the group of companies that have non-financial reporting obligations and unifies reporting standards in the form of European Sustainability Reporting Standards. These standards include a focus on the activities through which an organization has the greatest impact on the natural environment or society. As part of mandatory reporting, companies will also have to describe their sustainability objectives and measures, the processes in place to achieve these objectives and the level of achievement of these objectives (PwC, 2023).

Table 1.
Selected sets of competencies for sustainable development

Source	Glasser, 2016	Benders et al., 2016	Quendler, Lamb, 2016	Brundiers et al., 2021
Sustainable competencies	• Systems thinking, • Interpersonal Competence, • Normative competence, • Anticipatory skills, • Strategic competence, • An affinity for life, • Knowledge of the state and the planet, • Wise decision making, • Modelling sustainable behavior, • Social transformation	• Life cycle thinking, • Understanding eco-design principles, • Systems thinking, • Multidisciplinary approach to problem solving, • Ability to work in interdisciplinary groups, • Creativity, • Negotiation skills, • Social entrepreneurship attributes, • High business ethics, • Long-term thinking	• Competence for sustainable development: o system orientation, o future orientation, o social responsibility, • Skills: o environmental impact analysis, o economic optimization, o implementation of sustainable development concepts, o communication, o leadership and teamwork, • Knowledge of sustainability: o general, o how to analyze environmental impacts, o how to reduce environmental impact, o knowledge in economics, o knowledge of the value of nature, • Social aspects of sustainable development	• Systems thinking, • Anticipatory thinking, • Normative competence (value thinking), • Strategic competence (strategic thinking), • Interpersonal competence (collaboration), • Integrated problem-solving competence (metacompetence)

Source: own work based on (Brundiers et al., 2021; Burns et al., 2016; Glasser, 2016; Piwowar-Sulej, 2023; Quendler, Lamb, 2016).

In the case of people working in jobs and positions with duties connected with the achievement of company sustainable performance, sustainability-related competencies will be professional competencies. The latter are defined as competencies that enable one to perform the tasks of a particular occupation or position (Taradejna, 2014). In addition to hiring people responsible for sustainability policies, processes and reporting, it is important to build sustainable competencies among all employee groups. This is because everyone should practice sustainable thinking, which is about choosing decisions that do not have negative consequences for present and future generations (Deniz, 2016). This is because employees may not be aware that what they do not only directly affect the employer's financial performance, but also the achievement of organizational social and environmental goals. Therefore – drawing on the

International Labor Organization's proposal for environmental competencies – two groups of competencies for sustainable development can be proposed (see Table 2).

Table 2.
Competence for sustainable development - by groups of employees

Employee group	Competencies
All employees	• awareness of and respect for the environment and society; willingness to learn and improve in the field of sustainable development, • flexibility - ability to adapt to changing conditions, • adaptability to enable staff to acquire the theoretical and practical knowledge of new technologies and processes needed to green their workplaces and make them more socially inclusive, • ability to work as a team, responding to the need to work together within an organization to find solutions to reduce the organization's environmental footprint and negative social impact, • communication and negotiation skills, in order to promote the required changes among colleagues and external stakeholders of the enterprise, • entrepreneurial skills, to exploit the potential of low-carbon technologies to adapt and reduce environmental and social impacts
Representatives of sustainability-related professions (including green jobs)	• analytical and systems thinking, necessary to interpret and understand the need for change and the resources and inputs required to do so, • coordination, management and business skills, which may include an interdisciplinary approach to economic, social and environmental objectives, • strategic and leadership skills to help politicians and company managers identify appropriate incentives and create conditions conducive to the development of green production and transport and pro-social activities, • skills to innovate, identify opportunities and develop new strategies to respond to green and social challenges, • marketing skills to promote greener products and services and pro-social activities, • consultancy skills to support the company's external stakeholders in understanding green and pro-social solutions and the diffusion of green/pro-social technologies, • networking, IT, and language skills to operate in global markets

Source: own work based on (International Labor Organization, 2019; PARP, 2022).

The above considerations are both theoretical and practical. At this point, it is worth emphasizing that science provides managers with a number of benefits that help them to effectively manage their company, team and make better strategic decisions. Therefore, the next section of the article presents science mapping, which is used to better understand the direction of science, identify areas that need more attention, and support strategic decision-making in the given field of research (Chen et al., 2015).

3. Bibliometric analysis of publications on sustainable competencies

The literature review presented here was carried out using a science mapping approach, which relies mainly on bibliometric data and links between keywords (Chen et al., 2015). In the first step, for the phrase: "sustainable competencies" OR "competencies in sustainability" OR "competencies for sustainability" OR "competencies for sustainable development" OR

"sustainability competencies" (search area: title, abstract, keywords) on 8th November 2023 Scopus showed 342 documents. The search result was then narrowed down to articles written in English and published (in final stage of publication, excluding early view papers). A total of 225 documents were obtained. A list containing these documents was exported to a CSV file, which was used to develop a keyword linkage map in the VosViewer software (van Eck. Waltman, 2014).

The first article on the analyzed competencies was published in 2007 in the International Journal of Sustainability in Higher Education. As can be seen from the information presented in Figure 1, interest in the topic of sustainable competencies is growing year on year.

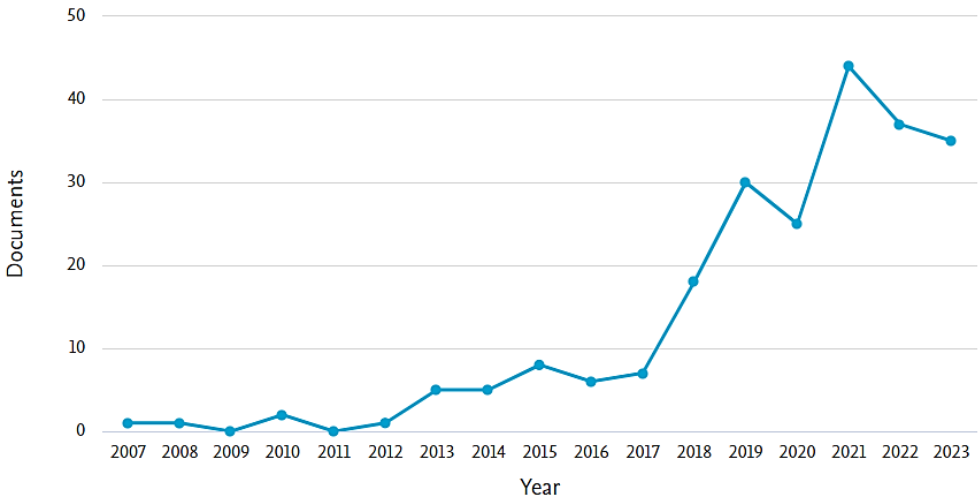

Figure 1. Number of publications on sustainable competencies according to the Scopus database (as for 8th November 2023).

Source: own elaboration using the analytical tools of the Scopus database.

Table 3 shows the titles of journals that published more than two articles on sustainable competencies. Journals specializing in education predominate in the sample.

Table 3.
The most productive journals publishing works on sustainable competencies

Journal	Number of articles
Sustainability (Switzerland)	71
International Journal of Sustainability in Higher Education	32
Journal of Cleaner Production	9
Environmental Education Research	7
Sustainability Science	6
Journal of Teacher Education for Sustainability	4
Frontiers in Sustainability	3
International Journal of Engineering Education	3

Source: own work.

The most productive authors (see Figure 2), published as many as 10 papers on the topic of competencies for sustainable development.

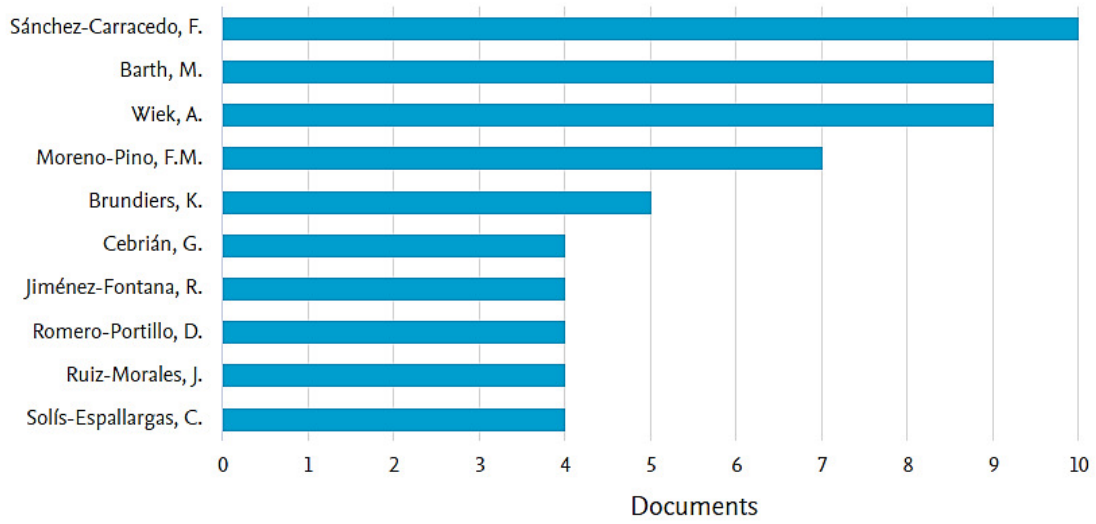

Figure 2. Most productive authors in the field of sustainable competence according to Scopus (as for 8th November 2023).

Source: own compilation using Scopus analytical tools.

Although the largest number of publications come from Spain and the United States, the most productive countries include representatives from the Americas, Europe and Asia (Figure 3).

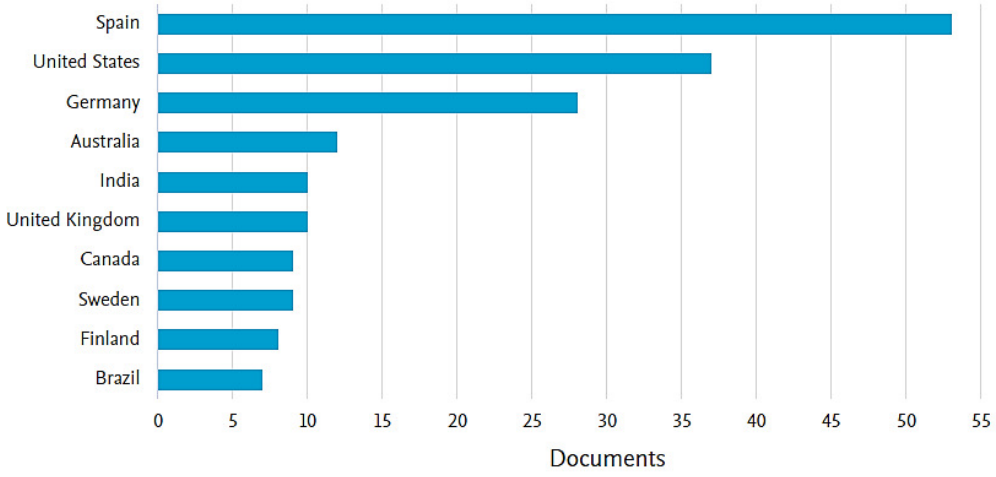

Figure 3. Countries with the most publications on sustainable competencies according to the Scopus database (as for 8th November 2023).

Source: own compilation using Scopus analytical tools.

A total of 765 author keywords occurred in the analyzed publications. As some of the words meant the same thing but were written differently (e.g. education for sustainable development and education for sustainability), the Thesaurus tool was used to clean the keyword database of unnecessary repetition. After setting the number of occurrences of each word to 5 (as indicated by van Eck and Waltman (2014) 20 keywords that formed the map shown in Figure 4.

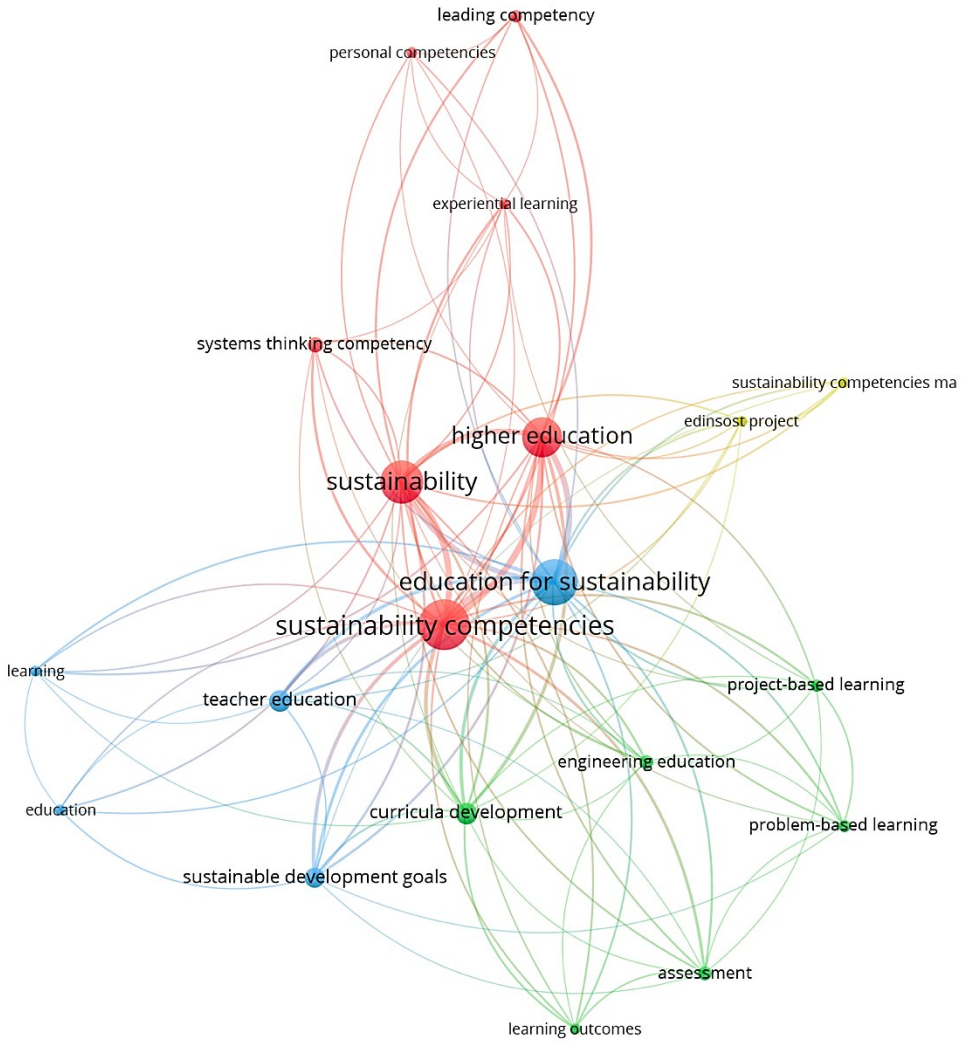

Figure 4. Map of keyword associations.

Source: own elaboration using VosViewer software.

Figure 4 shows the clusters of author keywords. Starting with the largest, they are:

- Red cluster (7 items): This cluster focuses on higher education's role in teaching sustainability, with an emphasis on developing specific competencies. It includes terms like "Higher education", "Sustainability competencies", and "Experiential learning". This suggests a focus on how higher education can integrate sustainability into its curriculum and the specific competencies needed for sustainability, like systems thinking, leadership, and personal skills.
- Green cluster (6 items): This cluster seems to focus on the methods and approaches of teaching in engineering and related fields, with an emphasis on curricula development and innovative learning methodologies like project-based and problem-based learning. It reflects an educational approach that is hands-on and problem-oriented, likely with sustainability as a context, mainly applied for engineering education.

- Blue cluster (5 items): This cluster is more broadly focused on the concept of education for sustainability and on the overall approach and philosophy of integrating sustainability into education at various levels. It also related to education of teachers who are responsible for teaching sustainability issues.
- Yellow cluster (2 items): The smallest cluster, relates to a particular project named "Edinost project" and its connection to development of sustainability competencies map.

4. Conclusions

Sustainable competencies are essential to address a wide range of environmental, social and economic challenges. They enable individuals and organizations to make responsible, ethical and sustainable choices that lead to positive outcomes for individuals, the planet, society and the economy. Employers should therefore value employees who possess not only traditional professional skills, but also sustainable competencies such as flexibility, collaboration, the ability to solve socially-oriented problems and concern for the environment, among others.

Disseminating knowledge about sustainable competencies is essential for raising awareness and bringing about change. This article educates readers about the role of sustainable competencies in today's working world. It can help them to better understand what skills are crucial for their career success. Giving concrete examples of sustainable competencies and their role in different professional fields can provide practical guidance for people who are looking for career development tips. Furthermore, the article shows how – i.e., through the use of sustainable competencies – employees can contribute to social and environmental progress.

With a view to the contribution of this article to management theory, the authors have identified different approaches to the analyzed competencies. In addition, they proposed a division of sustainable competencies, taking into account different professional groups. Using bibliometric analyses, they showed that the greatest research attention has so far been focused on education for sustainable development taking place in institutions set up for this purpose (e.g., universities). As this article demonstrates, there is a paucity of research on practices undertaken by employers as part of staff development. Furthermore, most of the research to date has been carried out in Spain, the US and Germany and has focused on selected competencies, including those related to environmental protection. As sustainable competencies require knowledge from multiple disciplines such as environmental sciences, social sciences, economics and management, researchers – in future international research projects also bringing together authors from e.g. Central Europe – should also work in interdisciplinary teams to develop and test comprehensive theories and models. It would be important to recognize which competencies are particularly needed in different industries and how this phenomenon changes over time.

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COLLABORATIVE AND INCLUSIVE GOVERNANCE: KEY TO PRIORITIZING SUSTAINABLE AND SMART GROWTH CHALLENGES IN POLISH MUNICIPALITIES

Aldona PODGÓRNIAK-KRZYKACZ[1*], Justyna PRZYWOJSKA[2]

[1] University of Lodz, Faculty of Economics and Sociology, Department of Labour and Social Policy; aldona.podgorniak@uni.lodz.pl, ORCID: 0000-0003-0029-0418
[2] University of Lodz, Faculty of Economics and Sociology, Department of Labour and Social Policy; justyna.przywojska@uni.lodz.pl, ORCID: 0000-0002-1125-2225
* Correspondence author

Purpose: The purpose of the article is to gain deeper insight into the process of transformative governance in Polish municipalities.
Design/methodology/approach: The article presents the results of a survey conducted using an online survey technique in 2018 among mayors from 1236 municipalities in Poland. We employ regression analysis to examine whether the mayors' attitude towards collaboration moderates the relationship between the municipalities' engagement in cooperation and the mayors' prioritization of challenges associated with sustainable and smart growth.
Findings: Based on the results of survey conducted in 1236 municipalities in Poland, we confirmed the existence of a relationship between municipal involvement in cooperation with diverse stakeholders and the prioritization of sustainable, smart growth challenges, as well as between mayor's attitude toward cooperation and the prioritization of sustainable, smart growth challenges. Greater capacity for collaborative governance fosters mayors' more comprehensive perceptions of sustainability challenges. We further demonstrate that attitude toward collaboration moderate the relationship between municipal engagement in collaboration and the prioritization of sustainable, smart growth.
Research limitations/implications: The limitations of the research include not taking into account other factors that may determine local policy priorities, such as the ability to obtain funding for sustainable development and smart community development projects. Second, our research is limited to an analysis of priorities and does not consider completed sustainable and smart community projects.
Practical implications: We recommend expanding municipal cooperation to include partnerships with supra-local expert actors who possess broader resources, skills, knowledge, and visions.
Social implications: The survey results highlight the need to educate residents about the challenges of sustainable and smart development and to influence the topics of debate during the municipal election campaign period.
Originality/value: What is new is the clarification of the importance of the interplay between the individual and organizational aspects of collaborative governance for the priorities of local development declared by mayors.

Keywords: collaborative governance, sustainability transition, municipalities, cooperation of municipalities, sustainable, smart local development.
Category of the paper: Research paper.

1. Introduction

Local governments have become important policy actors for sustainable development and play a key role in initiating and supporting the transition to sustainability. In particular, the significance of cities in this process is emphasized, as they are places where environmental, climate, demographic, and social problems converge, as well as opportunities and resources for accelerating change towards sustainable and smart development (Dawes, 2019; Hölscher, Frantzeskaki, 2021; Wolfram et al., 2016; Wolfram, Frantzeskaki, 2016). Cities can also play an important role in achieving deep greenhouse gas emission reductions and climate-resilient development (IPCC, 2023). The role of local governments (including those operating in smaller towns and villages) in the transition to sustainable development is highlighted by Goal 11 of the 2030 United Nations Sustainable Development Goals (Transforming Our World: The 2030 Agenda for Sustainable Development, 2015), which was directly dedicated to developing Sustainable Cities and Communities. Most of the other goals implicitly address the local level. Achieving at least 105 of the 169 SDG targets requires appropriate engagement and coordination with local and regional governments (OECD, 2020).

Sustainable and smart development of municipalities requires radical transformation of local systems to solve complex, long-term problems (Hölscher, Frantzeskaki, 2021). This transformation involves making fundamental irreversible changes in infrastructure, ecosystems, lifestyles, service delivery systems, urban innovation, institutions and governance (Elmqvist et al., 2019). Sustainability-oriented local leadership has been identified as a facilitator of the transition to sustainability, and as key to the implementation of the Sustainable Development Goals (Krellenberg et al., 2019; Valencia et al., 2019). According to Wittmayer et al. (2016) a clear focus of local authorities on radical change is a prerequisite for managing sustainability in a way that addresses the root causes of local challenges. In addition to prioritizing the goals of sustainable, smart development in local policies, effective transformation requires appropriate governance. Managing the transformation of local systems in line with the Sustainable Development Goals is a major challenge for local authorities (Wolfram et al. 2016), as they need to facilitate alignment, foresight and reflexive learning in order to recognise, anticipate and shape transformation dynamics and leverage points (Hölscher et al., 2019a; Hölscher, Frantzeskaki, 2021).

In practice, sustainability management in local government faces a number of structural, cultural and attitudinal barriers (Raffer et al., 2022). The article addresses the issue of sustainability transition governance at the local level in Poland and attempts to answer the question of whether Polish municipalities are ready for transition governance. On the formal-legal side, the localization of sustainability goals in Poland has been ensured by legal regulations such as, for example, the Act on the Principles of Development Policy (2006), the Environmental Protection Act (2001), the Act on Planning and Spatial Development (2003). They have guaranteed legitimacy and opportunities for the implementation of sustainable development activities and investments in Polish municipalities. Ways to implement SDG goals at the local level have also been identified in national sectoral strategies such as the National Urban Policy 2030, regional strategies and regional sectoral programs, and local development strategies. However, data from the Sustainable Development Report 2022 indicates that the implementation of SDG11 Sustainable Cities and Communities, which assumes making cities and human settlements inclusive, safe, resilient and sustainable, still faces significant challenges in Poland (Sachs et al., 2022). In particular, the air pollution index remains poor in comparison with other European countries, despite the slight improvement recorded. Previous research results also highlight the low involvement of Polish local governments (about 20%) in sustainable development activities and the rather high percentage of local governments still unaware of sustainable development challenges (about 38%) (Boguszewski et al., 2023). They also diagnosed insufficient leadership and low prioritization of current sustainability challenges by Polish mayors (Przywojska et al., 2019).

Accordingly, the purpose of our article is to gain deeper insight into the process of transformative governance in Polish municipalities. We analyze two of its dimensions: the municipality's ability to develop collaborative, inclusive governance and the mayor's local leadership oriented toward sustainable, smart development. We try to get an answer to the following research question: (1) What is the capacity of Polish municipalities to develop collaborative, inclusive governance? (2) How do mayors prioritize the challenges of sustainable, smart development? (3) Does the capacity of Polish municipalities to develop collaborative, inclusive governance affect the mayor's prioritization of sustainable, smart development challenges?

The article contributes to theory on collaborative, inclusive governance and its impact on the priorities assigned by local leaders for interventions toward sustainable smart development. What is new is the clarification of the importance of the interplay between the individual and organizational aspects of collaborative governance for the declared priorities of local development by mayors.

2. Literature review

Transformational governance refers to the management of radical changes in social-environmental systems to achieve a more sustainable state of these systems (Chaffin et al., 2016). It involves defining and mainstreaming sustainability issues and setting a transformation agenda, i.e. introducing a vision of sustainability and possible transformation pathways, followed by implementing innovations and experiments and monitoring the progress of transformation (Rotmans & Loorbach, 2009). Each of these stages of governance requires close collaboration between interdependent actors who work together to make decisions (Chang et al., 2017; Loorbach, 2010). Networked, interactive governance is considered a fundamental characteristic of the transition to sustainability (Chang et al., 2017).

Transformational management is also applied at the regional and local levels. Sustainable local transformation is a process of structural, multi-dimensional and radical change that can effectively guide the development of cities and municipalities towards sustainable development goals (McCormick et al., 2013). According to Westman and Castán Broto (2022) managing the transition to sustainability should be inclusive, collaborative, integrated, experimental and reflective. The sustainable governance approach necessitates that local governments collaborate with a multiplicity of stakeholders in order to achieve harmonisation of priorities, the development of shared visions, experimentation and the combination of disparate ideas and solutions (Hodson et al., 2017). Furthermore, the literature on urban climate change policy, which is regarded as a component of the transition to sustainability, indicates that similar features of transformative climate governance can be observed, including learning, participation, knowledge co-production, long-term thinking, experimentation and flexibility (Hölscher et al., 2019b). Additionally, researchers in the field of smart community development governance propose a governance approach predicated on participation and inclusion. The objective of such governance is to empower local communities in digital development planning and to ensure that all interests, perceptions, expectations and needs are taken into account in the process (Angelidou, 2015; Podgórniak-Krzykacz et al., 2020). Consequently, all three forms of governance (sustainable, climate and smart) are characterized by distributed power (polycentric governance), participation, high levels of information sharing, innovation supported by experimentation and learning in governance networks.

Governance of local transformation requires specific capacities of local actors to mobilize and direct the driving forces and dynamics of transformation (Hölscher et al., 2019a). Researchers agree that actors' capacities to create conditions for cooperation with citizens, public actors, private actors, NGOs and participatory learning, as well as Orchestrating capacity, meaning the ability to coordinate multi-stakeholder governance processes and share knowledge, play an important role (Hölscher et al., 2019a, 2019b). Indeed, at the stage of sustainable development policy formulation and implementation, open discussion,

consideration of the interests of different actors, involvement of different forms of knowledge, and consensus based on common goals and trust are essential (Christie, 2001). For this reason, the ability of local authorities to build flexible institutions, networks and cooperation is seen as playing an important role in effectively managing transitions to sustainable development (Evans et al., 2006; George, 2018; Grin et al., 2010; Loorbach, 2010; Meadowcroft et al., 2005; Wittmayer et al., 2014).

Similar conclusions were reached by Evans et al. (2006). They argue that local government coping with long-term sustainability challenges requires high institutional capacity manifested through strong local leadership with a vision for sustainability and a commitment to collaboration with stakeholders that shapes institutional learning capabilities. Bridging social capital, or the ability to build collaborative ties between organizations and groups in society, is also crucial. Public authorities can help to create and mobilize bridging social capital and increase civil society activity through appropriate policies (such as supporting the voluntary sector, promoting citizen participation, and the ability to listen to and channel citizen demands). In turn, the institutional capacity of local governments to mobilize and lead cooperation and to engage civil society is important for generating local innovation and experimentation. Indeed, niche, innovative solutions play an important role in transforming entrenched, unsustainable systems (McCormick et al., 2013; Raffer et al., 2022). Evans et al. (2006) call for a "dynamic approach" to sustainable development management, based on the high social and institutional capacity of local governments, allowing them to better respond to the need for good governance and reflective management, and to more effectively achieve sustainable development goals.

Cooperation between local governments and local actors as the foundation of local transformation management is based on mutual interactions and enables joint institutional learning. This process involves the integration of local and expert knowledge. Institutional learning is in turn translated into urban practice or policy (MacDonald et al., 2022). Healey (2006) explains this mechanism as follows: the collective learning that occurs during collaborative initiatives feeds mainstream urban governance and ultimately transforms embedded cultural values and formal and informal mechanisms for policing governance. In this context, it is particularly important to include marginalized perspectives so that transformative governance is inclusive and equitable.

3. Methods

3.1. Research assumptions

This section illustrates the data, methods and models used in this study to assess the impact of municipalities' ability to develop collaborative governance on the prioritization of sustainable and smart development challenges. We assume that Polish local governments are moving towards a more sustainable system by collaborating with stakeholders, learning and using the best available information. Chaffin et al. (2016) describe this approach as proactive.

We consider the capacity of local authorities to develop collaborative governance through the prism of two aspects: (1) mayors' attitudes toward collaboration and (2) municipality's involvement in cooperation. We analyze the municipality's orientation toward shaping a more sustainable system through the prism of the mayor's prioritization of the challenges of sustainable, smart growth in municipal governance. In our study, we analyze mayors' attitudes due to their strong position in the municipal power system. According to the classification of political leadership developed by Mouritzen and Svara (2002), in Poland we are dealing with a strong mayor form (Swianiewicz et al., 2018). Previous research has confirmed that strong mayor political leadership determines the dominant role of mayors in integrating current challenges into the local political agenda and the dominant style of municipal governance (Swianiewicz et al., 2018).

The architecture of the methodology is shown in Figure 1. The first step is to assess mayors' attitudes toward collaboration. Secondly, we assess the extent of collaborative networks. Finally, we assess the impact of both factors on the prioritization of sustainable and smart growth challenges. In addition, we assume that the mayor's attitude toward cooperation moderates the relationship between the municipality's involvement in cooperation and the mayor's prioritization of sustainable smart growth challenges.

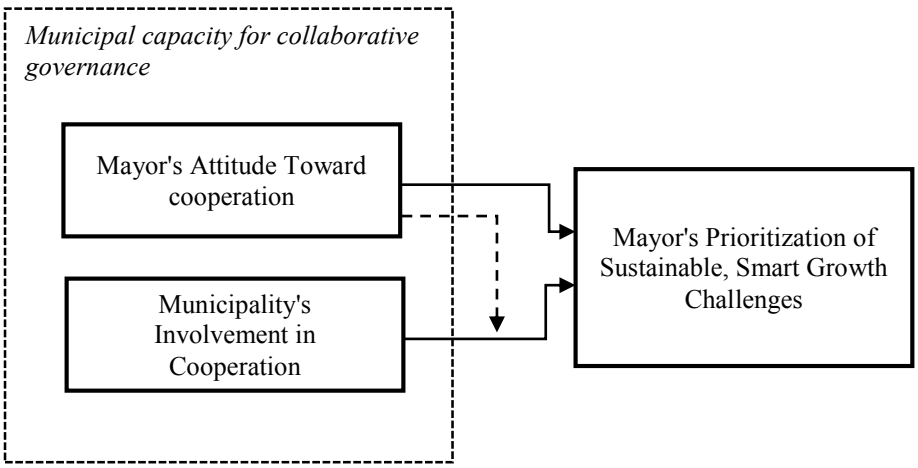

Figure 1. Methodological scheme.

Source: own elaboration.

3.2. Measurement

The measurement of the variables detailed in the study's assumptions is presented in Table 1.

Table 1.
Measurement of variables

Construct	Components	Items	Scale
V1. Mayor's Attitude Toward Cooperation	V1.1 Mayor's attitude to initiating, mobilizing and strengthening local partnerships	V1.1.1 Mayor's perception of the importance of the task of building local partnerships V1.1.2 Mayor's perception of the importance of the task of supporting the development of civil society V1.1.3 Mayor's perception of the importance of the task of developing civil dialogue	scale of 1-5, where: 1 - This is not the job of the president/mayor 2 -Little significance 3- Moderate importance 4 - High importance 5 - great importance
	V1.2 Mayor's attitude toward involving stakeholders in the local development management process	V1.2.1 Mayor's perception of the need to directly involve residents in local decision-making V1.2.2 Mayor's perception of the need to take into account the opinions and needs of excluded residents or those at risk of social exclusion in local decision-making. V1.2.3 Mayor's perception of the need to take into account the opinions and needs of national and ethnic minorities in the municipality in local decision-making V1.2.4 Mayor's perception of the need to take into account the opinions and needs of NGOs in local decision-making V1.2.5 Mayor's perception of the need to take into account the opinions and needs of local entrepreneurs in local decision-making	scale of 1-5, where: 1 - Strongly disagree 2 - I disagree 3 - Neither agree nor disagree 4- I agree 5 - Strongly agree
V2. Municipality's Involvement in Cooperation		V2.1 Groups of residents V2.2 Local action groups V2.3 Universities V2.4 Business environment institutions, e.g. development agencies, technology parks, scientific and research institutions V2.5 Non-governmental organizations in the municipality V2.6 Non-governmental organizations in the province V2.7 National NGOs V2.8 Local entrepreneurs V2.9 Consulting firms, experts V2.10 Economic self-government V2.11 Municipal business groups other than the economic self-government	scale of 1-5, where 1 - no cooperation, 2 poor cooperation 3 - medium cooperation 4 - great cooperation 5 - very high cooperation

Cont. table 1.

V3 Prioritization of Sustainable, Smart Growth Challenges	V3.1 Development of social policies to provide adequate housing, health care, education, culture and take care of the needs of vulnerable groups (the elderly, the young, the unemployed, etc.).	A score of 1 means "low priority", and a score of 5 means "high priority"
	V3.2 Environmental protection and safe, responsible use of natural resources	
	V3.3 Creation of a closed-loop municipal economy (development of a circular economy)	
	V3.4 Stimulation of economic growth and employment, attraction of investors, creation of investment opportunities	
	V3.5 Improvement of local infrastructure, communications and transportation	
	V3.6 Improvement of the integration of minorities, e.g. ethnic, religious or cultural, and emphasize diversity and tolerance in the local community	
	V3.7 Responding to global trends, technological revolution	
	V3.8 Implementation of the smart city concept in the municipality	

Source: own elaboration.

The proposed scales for measuring the Mayor's Attitude Toward Cooperation and the Municipality's Involvement in Cooperation are those of the authors. On the other hand, the measurement scale for Prioritization of Sustainable, Smart Growth Challenges was developed based on a modified scale used by Przywojska et al. (2019).

3.3. Data and data analysis methods

Data for the analyses were obtained from an online survey conducted in 2018. The survey covered mayors from 1236 municipalities in Poland (n = 1236), i.e. half of all municipalities in Poland (N = 2478). The structure of the sample is similar to that of the population from the point of view of the type of municipality - Table 2 (in Poland, 62.8% of municipalities are rural, 24.9% are urban-rural, 9.6% are urban municipalities, 2.7% are cities with county rights, the similarity index of structures is 97%). The sample also reflects well the territorial distribution of municipalities (by province, i.e. NUTS2 without excluding the Warsaw Capital Region).

Table 2.
Characteristics of the local government units in the sample (n = 1236)

Specification		n	%
Type of municipality	City with district rights	42	3.4
	Municipality	114	11.8
	Urban-rural municipality	274	22.5
	Rural municipality	758	62.2
	No answer.	18	1.5

Source: own elaboration.

In the first step of the analysis, we calculated descriptive statistics (mean, median, standard deviation) for 3 variables: attitudes toward collaboration, involvement in cooperation and prioritization. The results are discussed in the subsection Polish municipalities' capacity for collaborative, inclusive governance and mayor's local leadership priorities.

In the second step, we conducted an exploratory factor analysis with Varimax rotation for the variable Mayor's Attitude Toward Cooperation to confirm the validity of the separation of the two subscales and then confirmatory factor analyses for all 3 variables Mayor's Attitude Toward Cooperation, Municipality's Involvement in Cooperation and Prioritization of Sustainable, Smart Growth Challenges. These were aimed at validating the proposed measurement models. Calculated for each construct were GFI, AGFI, CFI, RMSEA, PCLOSE, χ statistics2, df = 19, $p < 0.001$, $\chi 2$ / df and Composite Reliability. The results of these analyses are presented in the subsection Validation of measurement tools.

In the third step of the analyses, we calculated descriptive statistics for the new constructs and correlation coefficients between them. Linear regression models were constructed to test the hypotheses. The results are presented in the subsection Prioritizing the challenges of sustainable, smart development and its determinants.

4. Results

4.1. Polish municipalities' capacity for collaborative, inclusive governance and mayor's local leadership priorities

The distributions of each indicator are presented in Table 3.

Table 3.
Descriptive statistics (n = 1236)

Specification		% of responses						Statistics			
		1	2	3	4	5	TP/ BO	M	Me	SD	S
V1	**Mayor's Attitude Toward Cooperation**										
V1.1	***Mayor's attitude to initiating, mobilizing and strengthening partnerships - The mayor's perception of the importance of the following tasks:***										
V1.1.1	Creating local partnerships	0.2	3.6	27.8	47.5	5.6	15.4	3.65	4.00	0.68	-0.41
V1.1.2	Supporting the development of civil society	0.6	4.3	23.6	50.2	5.7	15.5	3.66	4.00	0.71	-0.77
V1.1.3	Development of civil dialogue	0.5	1.1	12.5	57.2	14.4	14.3	3.98	4.00	0.65	-0.78
V1.2	***Mayor's attitude towards involving stakeholders in local development management process - The mayor's perception of the following needs:***										
V1.2.1	Directly involve residents in local decision-making	0.9	1.4	7.8	56.6	27.5	5.7	4.15	4.00	0.70	-1.12
V1.2.2	Taking into account in decisions the opinions and needs of residents who are excluded or at risk of social exclusion	0.4	1.2	13.4	65.4	13.6	6.0	3.96	4.00	0.61	-0.76

Cont. table 3.

V1.2.3	Taking into account in decision-making process the opinions and needs of national and ethnic minorities in the municipality	2.3	5.5	41.2	39.6	4.9	6.6	3.42	3.00	0.78	-0.55
V1.2.4	Taking into account the opinions and needs of NGOs in decision-making process	0.4	1.6	10.3	67.8	13.9	6.0	3.99	4.00	0.60	-0.93
V1.2.5	Taking into account the opinions and needs of local entrepreneurs in decision-making process	0.4	1.1	8.8	67.9	15.6	6.2	4.04	4.00	0.59	-0.86
V2	**Municipality's Involvement in Cooperation**										
V2.1	Groups of residents	1.4	7.0	25.3	36.1	25.0	5.2	3.80	4.00	0.96	-0.50
V2.2	Local action groups	1.7	2.6	15.9	39.1	35.0	5.7	4.09	4.00	0.90	-1.01
V2.3	Universities	0.1	23.5	28.6	26.1	11.7	6.4	2.40	2.00	1.11	0.42
V2.4	Business environment institutions, such as agencies	21.0	31.0	24.1	12.0	4.6	7.4	2.44	2.00	1.12	0.47
V2.5	NGOs from the municipality	1.9	5.0	15.8	39.6	31.9	5.9	4.01	4.00	0.95	-0.95
V2.6	Non-governmental organizations from the province	12.2	31.3	32.3	14.6	2.8	6.9	2.62	3.00	0.99	0.20
V2.7	National NGOs	26.8	32.8	22.7	8.6	2.3	6.9	2.21	2.00	1.04	0.59
V2.8	Local entrepreneurs	0.6	6.2	24.7	41.4	21.0	6.1	3.81	4.00	0.88	-0.44
V2.9	Consulting firms, experts	12.2	28.5	32.2	18.0	2.7	6.5	2.68	3.00	1.02	0.08
V2.10	Economic self-government	29.0	19.5	23.3	14.0	5.4	8.8	2.42	2.00	1.24	0.38
V2.11	Other than the economic self-government, groups of entrepreneurs in the municipality	35.5	19.3	17.6	7.0	3.2	17.2	2.07	2.00	1.15	0.81
V3	**Prioritization of Sustainable, Smart Growth Challenges**										
V3.1	Development of social policies to provide adequate housing, health care, education, culture and take care of the needs of vulnerable groups (such as the elderly)	0.3	1.1	9.8	32.0	51.5	5.3	4.41	5.00	0.75	-1.19
V3.2	Environmental protection and safe, responsible use of natural resources	0.1	1.3	11.7	39.6	42.5	4.9	4.29	4.00	0.74	-0.78
V3.3	Shaping the circular municipal economy (development of the circular economy)	2.3	5.6	30.8	41.4	13.3	6.6	3.62	4.00	0.89	-0.54
V3.4	Stimulate economic growth and employment, attract investors, create investment opportunities	0.2	2.1	8.7	31.4	52.4	5.2	4.41	5.00	0.76	-1.24
V3.5	Improve local infrastructure, communications and transportation	0.2	0.4	3.7	22.7	67.8	5.3	4.66	5.00	0.59	-1.89
V3.6	Improve the integration of minorities, e.g. ethnic, religious or cultural, and emphasize diversity and tolerance in the local community	14.3	18.4	32.1	21.9	6.8	6.4	2.88	3.00	1.15	-0.08
V3.7	Responding to global trends, technological revolution	8.9	17.7	35.7	26.1	5.8	5.8	3.02	3.00	1.04	-0.22
V3.8	Implementation of the smart city concept in the municipality	12.9	19.2	33.6	22.1	5.6	6.6	2.87	3.00	1.10	-0.10

Note. TP/BO - hard to say/no answer, M - mean, Me - median, SD - standard deviation, S - skewness

Source: own elaboration.

In the case of the mayor's Attitude to Involve Stakeholders in the Local Development Management Process (V2), the averages are close to 4 for all items except "taking into account in decisions the opinions and needs of national and ethnic minorities in the municipality" - M = 3.42 (SD = 0.78, Me = 3). The mayor's attitude to initiating, mobilizing and strengthening partnerships is rated slightly lower (mean of about 3.65, higher is only for "development of civil dialogue" - M = 3.98), although the median reaches 4 for all items (except for the aforementioned V1.2.3). The greatest importance is given to the direct involvement of residents in local decision-making (M = 4.15, SD = 0.70).

The municipality's involvement in cooperation takes place in various fields, yet for only four groups of stakeholders - local action groups, ngo's from the municipality, local entrepreneurs and residents' groups - the average rating is about 4 (the median is also 4). For the rest of the cooperation partners, the average rating does not exceed 3, which means that the cooperation is average or even weak.

For development priorities, the median reaches the maximum value (5) for three issues: V3.1 Developing social policies to ensure adequate housing, health care, education, culture and taking care of the needs of vulnerable groups (e.g., the elderly), V3.4 Stimulating economic growth and employment, attracting investors, creating investment opportunities, and V3.5 Improving local infrastructure, communications and transportation. On the other hand, the lowest (average max 3) rating is given to the importance of such challenges as: improving integration of minorities and emphasizing diversity and tolerance in the local community, implementing the smart city concept in the municipality, and responding to global trends, technological revolution.

4.2. Validation of measurement tools

The reliability of each of the scales analyzed is satisfactory. The value of the coefficient of alpha-Cronbach's coefficient for the scale Prioritization of the Challenges of Sustainable, Smart Growth reaches 0.811, while for the scale Municipality's Involvement in Cooperation: α-C = 0.866. Overall measured (with eight indicators), the reliability of the scale Attitude of the mayor to cooperation is also adequate - α-C = 0.735, with α-C = 0.756 for the subscale Mayor's Attitude to Involve Stakeholders in the Local Development Management Process, and α-C = 0.601 for the short, three-item scale Mayor's Attitude to Initiate, Mobilize and Strengthen Partnerships (and thus exceeds the acceptable threshold of 0.6 for such short scales (Rószkiewicz, 2011)). This confirms that the proposed set of variables fulfills its purpose - it allows for reliable measurement of the three phenomena in question.

At the same time, it should be emphasized that the skewness of the distribution of individual indicators is quite low, in the case of single variables skewness exceeds in absolute value 1, although given the sample size, it allows the use of factor methods. We should add that the sample size is perfect for factor models: n > 1000 (Comrey, Lee, 2013; Tabachnick, Fidell, 2007).

KMO = 0.746 and Bartlett's significant test (Field, 2000) confirm that the adopted set of indicators is appropriate for measuring the Mayor's Attitude Toward Cooperation (Table 4). Exploratory factor analysis, with Varimax rotation (Hair et al., 1998) confirmed the initial assumptions - there are two subscales within the Mayor's Attitude Toward Cooperation scale: F1, explaining 37.3% of the variance in the latent variable, which includes indicators of the mayor's attitude toward involving stakeholders in the local development management process, and F2, explaining 17.6% of this variance, concerning the mayor's attitude toward initiating, mobilizing and strengthening partnerships (Table 4).

Table 4.
Mayor's Attitude Toward Cooperation - exploratory factor analysis results

Items		**F1**	**F2**	**C**
V1.2.4	Taking into account the opinions and needs of NGOs in decisions	**0.846**	0.083	0.723
V1.2.5	Taking into account the opinions and needs of local entrepreneurs in decisions	**0.831**	0.014	0.691
V1.2.2	Taking into account in decisions the opinions and needs of residents who are excluded or at risk of social exclusion	**0.744**	0.101	0.563
V1.2.3	Taking into account in decisions the opinions and needs of national and ethnic minorities in the municipality	**0.592**	0.197	0.389
V1.2.1	Directly involve residents in local decision-making	**0.575**	0.150	0.354
V1.1.2	Supporting the development of civil society	0.174	**0.794**	0.660
V1.1.3	Development of civil dialogue	0.087	**0.790**	0.632
V1.1.1	Creating local partnerships	0.079	**0.609**	0.377
% of total variance explained		37.26	17.59	x

Note. C - communalities. N = 1024. KMO = 0.746, Bartlett's sphericity test: χ^2 (28) = 2081.9, p < 0.001***.

Source: own elaboration.

The results of confirmatory factor analysis (CFA) confirm the assumptions made for the three constructs (Figure 2). Confirmatory factor analysis was conducted using the AMOS program.

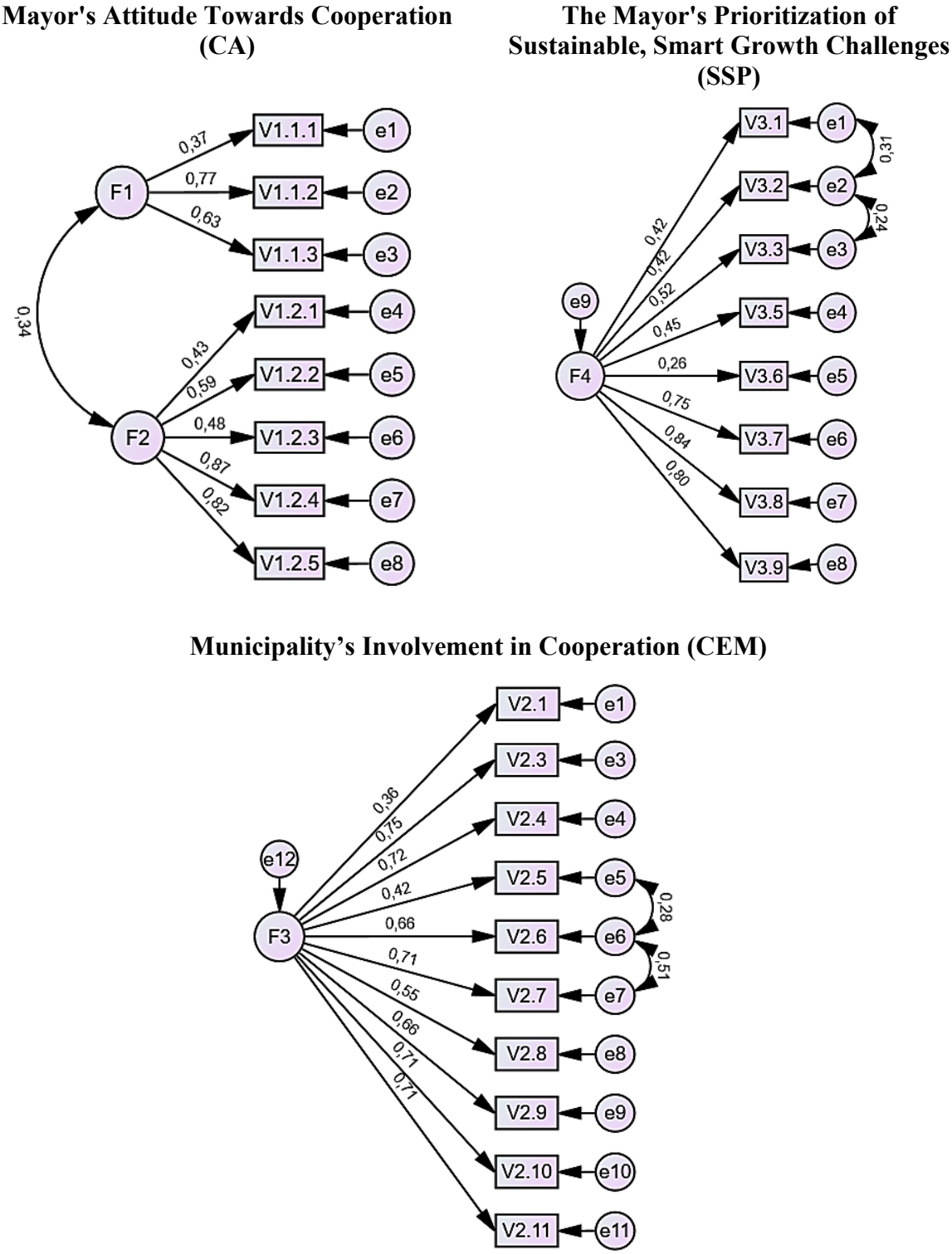

Figure 2. Factor structure of the measurement models of the three constructs: Mayor's Attitude Toward Cooperation (CA), Municipality's Involvement in Cooperation (CEM) and Prioritization of Sustainable Smart Growth Challenges (SSP).

Source: own elaboration.

In the measurement model of municipal involvement in cooperation, a very low loading (only 0.24) was obtained for local action groups (V2.2). It was decided to exclude this variable from the model. Figure 2 shows the CFA results after omitting this variable.

As for CA - Mayor's Attitude Toward Cooperation, the two-factor measurement model was confirmed. All coefficients are statistically significant and have acceptable values above 0.3, although for variables V1.1.1, V1.2.1 they are quite low (below 0.5). The model's fit is satisfactory. GFI = 0.961, AGFI = 0.927, CFI = 0.932, so they are greater than the threshold value of 0.9. Also, the RMSEA is acceptable - it is 0.085, the confidence interval for RMSEA has limits (0.073; 0.097), and PCLOSE < 0.001, so it is lower than 0.05 (which, however, does not disqualify the model). The value of the statistic $\chi2 = 159.16$, df = 19, $p < 0.001$, $\chi2 / df = 8.377$. The proposed model for measuring the Mayor's Attitude Toward Cooperation is, therefore, an appropriate one. Furthermore, it can be observed that the subscales of the CA scale exhibit a moderately strong, statistically significant correlation with one another. (r = 0.34***). Composite Reliability (CR) exceeds the threshold value (0.6 - (Fornell, Larcker, 1981)) - overall for the CA scale: CR = 0.840, for F1: CR = 0.784, and for F2: CR = 0.624. This confirms the internal consistency of these scales.

Assessing the properties of the scale of Municipality's Involvement in Cooperation, the measurement model confirms the relevance of ten indicators ($p < 0.05$), for most variables (except V2.1. resident groups: coefficient 0.36 and V2.4. business environment institutions: coefficient 0.42), loadings are higher than 0.4 as well as than 0.5. Following Hair et al. (1998), as well as Costello and Osborne (2005), each item can be considered at least adequate (factor loadings > 0.3), and for most items factor loadings (over 0.5) are considered practically significant. Similarly, Tabachnick and Fidell (2007), following Comrey and Lee (2013), suggested using more stringent cut-offs going from 0.32 (poor), 0.45 (fair), 0.55 (good), 0.63 (very good) or 0.71 (excellent). In line with these approaches, each proposed variable (item) was included in the analysis in the next steps. The fit of the model is good: GFI = 0.940, AGFI = 0.901, CFI = 0.935, so they are greater than the threshold value of 0.9. Also, the RMSEA is acceptable - it is 0.089, the confidence interval for RMSEA has limits (0.080; 0.099), and PCLOSE < 0.001. The value of the statistic $\chi2 = 286.50$, df = 33, $p < 0.001$, $\chi2 / df = 8.682$. The proposed model for measuring the Mayor's Attitude Toward Cooperation is therefore good. Composite Reliability is high - CR = 0.868, which confirms internal consistency.

As for the SSP scale - Prioritizing the Challenges of Sustainable, Smart Growth, again all indicators are statistically significant ($p < 0.05$). The majority of variables exhibited loading values exceeding 0.4. However, for V3.6, the loading value was relatively low, approaching the cutoff point of 0.3 (0.263). The model demonstrates an adequate fit to the data: GFI = 0.964, AGFI = 0.929, CFI = 0.949, so they are greater than the threshold value of 0.9. Also, the RMSEA is acceptable - it is 0.081, the confidence interval for RMSEA has limits (0.069; 0.0939), and PCLOSE < 0.001. The value of the statistic $\chi2 = 150.19$, df = 18, $p < 0.001$, $\chi2 / df = 8.344$. The proposed model for measuring the Mayor's Attitude Toward Cooperation is therefore good. Composite Reliability is high - CR = 0.792, which confirms internal consistency.

For all constructs, an overall score was determined as the sum of scores obtained on a given scale. In the case of CA, the total score for both subscales (F1 and F2) and the overall score (CA) were determined.

4.3. Prioritization of the challenges of sustainable, smart growth and its determinants

The CA variable can take values between 8 and 40, with a higher value of the variable indicating the Mayor's Attitude Toward Cooperation at a higher level. Most of the results for the surveyed municipalities (97%) range from 24 to 38, and 76% range between 28 and 34. Also, the mean M = 30.76 indicates a high overall level of this attitude, and SD = 3.2 indicates a high homogeneity of results (Table 5). Both the mayor's attitude toward including stakeholders in the local development management process (F1) and the mayor's attitude toward initiating, mobilizing and strengthening partnerships (F2) are high.

Table 5.
Descriptive statistics and correlation coefficients for variables

No	Variable	Range	Descriptive statistics				Pearson's correlation (r)				
			n	M	SD	S	1	2	3	4	5
1	CA	8÷40	1024	30.76	3.20	-0.44	1				
2	F1	3÷15	1025	11.27	1.51	-0.73	0.695***	1			
3	F2	5÷25	1233	19.29	2.51	-0.41	0.892***	0.296***	1		
4	CEM	8÷40	968	27.96	7.11	0.48	0.337***	0.298***	0.263***	1	
5	SSP	10÷50	1115	30.14	4.71	-0.26	0.454***	0.416***	0.328***	0.455***	1

Note. M - mean, SD - standard deviation, S - skewness. *** $p < 0.01$.

Source: own elaboration.

At a relatively high level is the Municipality's Involvement in Cooperation (CEM), with a mean of 27.96 (standard deviation = 7.11) and a possible range from 8 to 40. The majority of the results (96%) fall within the range of 15 to 41, with 60% falling between 22 and 33.

The level of Prioritization of the Challenges of Sustainable, Smart Growth (SSP) is moderately high, with a mean of 30.14 (SD = 4.71) and a possible range of 10 to 50. The majority of respondents (96%) score above 22, with 86% scoring between 24 and 37. No respondents scored higher than 40. All variables exhibit a low degree of skewness in their distribution.

Prioritization of Challenges is significantly positively correlated with Municipality's Involvement in Cooperation (r = 0.455). It is also significantly positively correlated with the Mayor's Attitude Toward Cooperation - measured overall (r = 0.454), as well as the mayor's attitude toward including stakeholders in the local development management process (r = 0.416) and the mayor's attitude toward initiating, mobilizing and strengthening partnerships r = 0.328). Thus, the Mayor's Attitude Toward Cooperation, which, according to the theoretical model, is a moderator of the relationship between Prioritization of Challenges (dependent variable) and the Municipality's Involvement in Cooperation (independent variable), is quite strongly related to the dependent variable, but is also significantly positively and moderately strongly related to the independent variable (r = 0.337). In order to investigate whether the

Mayor's Attitude Toward Cooperation has a moderating effect in the relationship between the Municipality's Involvement in Cooperation and Prioritization of the Challenges of Sustainable, Smart Growth the moderating variable analysis was performed by using the SPSS PROCESS macro (Model 1; 5,000 bootstrap sample) (Hayes, 2022).

According to the results, the Municipality's Involvement in Cooperation has a significant effect on Prioritization of Challenges (B = 0.311, t = 14.885, p < 0.001, 95% CI [0.270, 0.352]) - model 1a. With the addition of Mayor's Attitudes Toward cooperation to the model, CEM effect is still statistically significant and correlation is positive - model 1b (Table 6). Standard Beta coefficients are similar to both independent variables in model 1b (0.345 for CEM and 0.339 for CA). The model with moderator (including variable measuring interaction between CA and CEM) confirms that the relationship between the Municipality's Involvement in Cooperation and Prioritization of Challenges remained significant and even increased (B = 0.620, t = 3.453, p = 0.001, 95% CI [0.267, 0.972]). The degree of explanation for the variation in Prioritization is higher when the moderator is included (R-squared = 0.320).

Table 6.
Model of SSP - regression without and with CA moderation effect (n = 811).

		B	SE	Beta	t	p	LLCI	ULCI	ANOVA	R-sq
Model 1a	Const	21.324	0.605		35.223	<0.001***	20.135	22.512	F(1; 809) = 221.6; p < 0.001***.	0.215
	CEM	0.311	0.021	0.464	14.885	<0.001***	0.270	0.352		
Model 1b	Const	8.313	1.319		6.301	<0.001***	5.723	10.902	F(2; 808) = 186.5; p < 0.001***.	0.316
	CEM	0.231	0.021	0.345	11.113	<0.001***	0.190	0.272		
	CA	0.496	0.045	0.339	10.916	<0.001***	0.407	0.586		
Model 1c	Const	-2.350	5.067		-0.464	0.643	-12.296	7.5956	F(3; 807) = 126.5; p < 0.001***.	0.320
	CEM	0.620	0.179	0.925	3.453	0.001***	0.267	0.972		
	CA	0.837	0.163	0.572	5.138	<0.001***	0.518	1.157		
	CEM* CA	-0.012	0.006	-0.699	-2.179	0.030**	-0.023	-0.001		

Note. B - regression coefficient, SE - standard error, t - t-statistic, R-sq - R-squared, LLCI/ULCI - lower/upper limit of 95% CI *** p < 0.01.

Source: own elaboration.

Table 7.
Conditional effect of local predictor at values of the moderator

	CA level	Effect	SE	t	p	LLCI	ULCI
Mayor's cooperative attitude							
Low	27.518	0.281	0.031	9.131	<0.001***	0.220	0.341
Medium	30.721	0.241	0.021	11.348	<0.001***	0.199	0.283
High	33.925	0.202	0.025	8.130	<0.001***	0.153	0.250

Source: own elaboration.

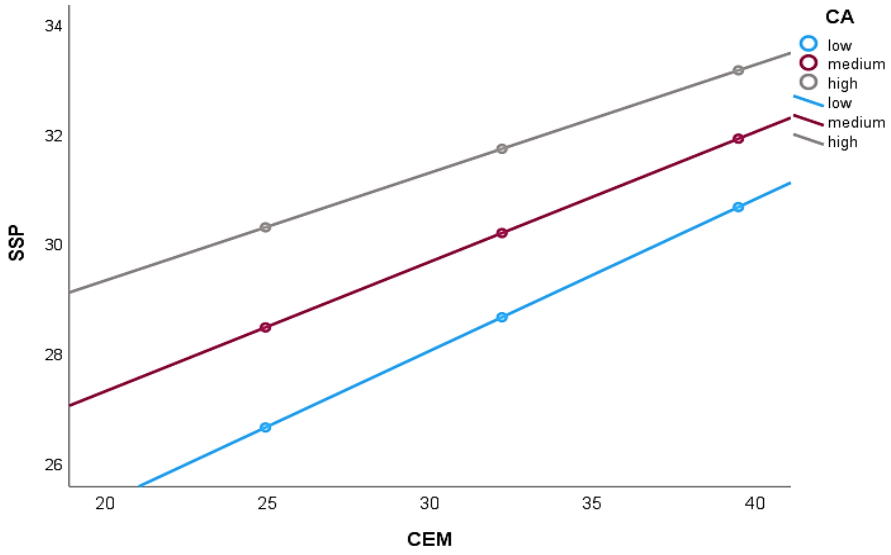

Figure 3. The moderator effect of Mayor's Attitude to Cooperation in the relations between Municipality's Involvement in Cooperation and Prioritization of Smart Sustainable Growth Challenges. Source: own elaboration.

The Mayor's Attitude moderates the relationship between the Municipality's Involvement in Cooperation and Prioritization of Challenges such that the higher the level of the Mayor's Attitude to Cooperation, the smaller the effect of the Municipality's Involvement in Cooperation on Prioritization of Challenges (Table 7). Although regardless of the level of Attitude, the effect of Involvement on Prioritization remains statistically significant ($p < 0.001$), and the analysis conducted using the Johnson-Neyman method did not indicate a threshold value for this relationship, nevertheless, if the mayor is more collaborative, the degree of the municipality's involvement in cooperation with stakeholders is less important. Conversely, if the mayor is less collaborative, the degree of the municipality's involvement in cooperation somehow forces the municipality to set its priorities in such a way that they are more concerned with the challenges of sustainable, smart growth. It is noteworthy that the standardized Beta coefficient for CEM (Beta = 0.925) is high, thereby confirming the importance of the municipality's involvement in cooperation. However, the interaction effect of CEM and CA, which weakens the effect of the municipality's involvement, is also quite strong (Beta = -0.699, model 1c).

If two variables are included in the model, disaggregating the measure of the Mayor's Attitude Toward Cooperation (F1 and F2), both the effect of the mayor's attitude toward involving stakeholders in the local development management process and toward initiating, mobilizing and strengthening partnerships is, ceteris paribus, statistically significant and favorable for the degree of prioritization of the challenges of sustainable, smart municipal development (Table 8). Beta standardized coefficients indicate that the Municipality's Involvement in Cooperation remains the most important (Beta = 0.355, model 2b), and the mayor's attitude toward including stakeholders in the local development management process (F2) is slightly more important (Beta = 0.249) than his attitude toward initiating, mobilizing and strengthening partnerships (F2, Beta = 0.187).

Table 8.
Model of SSP - regression without and with F1 and F2 moderation effect

		B	SE	Beta	t	p	LLCI	ULCI	ANOVA	R-sq
Model 2a	Const	21.324	0.605		35.223	<0.001***	20.135	22.512	F(1; 809) = 221.6; p < 0.001***.	0.215
	CEM	0.311	0.021	0.464	14.885	<0.001***	0.270	0.352		
Model 2b	Const	7.887	1.318		5.983	<0.001***	5.300	10.475	F(3; 807) = 129.3; p < 0.001***.	0.325
	CEM	0.224	0.021	0.355	10.789	<0.001***	0.184	0.265		
	F1	0.777	0.098	0.249	7.932	<0.001***	0.585	0.970		
	F2	0.366	0.061	-0.187	6.046	<0.001***	0.247	0.485		
Model 2c	Const	-0.707	5.138		-0.137	0.891	-10.793	9.380	F(5; 805) = 78.3; p < 0.001***.	0.327
	CEM	0.540	0.184	0.807	2.934	0.003**	0.179	0.902		
	F1	1.084	0.359	0.348	3.022	0.003**	0.380	1.788		
	F2	0.622	0.225	0.319	2.768	0.006**	0.181	1.063		
	CEM* F1	-0.012	0.013	-0.258	-0.931	0.352	-0.037	0.013		
	CEM* F2	-0.009	0.008	-0.328	-1.185	0.236	-0.024	0.006		

Note. B - regression coefficient, SE - standard error, t - t-statistic, R-sq - R-squared, LLCI/ULCI - lower/upper limit of 95% CI *** p < 0.01.

Source: own elaboration.

Consequently, the interaction effect (model 2c) is not statistically significant for either CEM*F1 (p = 0.352) or CEM*F2 (p = 0.236). This is also confirmed by Figure 4. With higher municipality's involvement in cooperation, there is greater importance attached to the challenges of sustainable, smart development in the municipality, and the nature of this relationship is the same with different combinations with the level of the mayor's attitude to cooperation at both levels analyzed (F1 and F2). So, also in this view, the mayor's attitude moderates the relationship between the municipality's involvement in cooperation and the municipality's priorities related to the challenges of sustainable, smart development, with both low, average and high mayor's attitude to involving stakeholders in the local development management process, moderating effect of the mayor's attitude toward initiating, mobilizing and strengthening partnerships is of the same nature (and conversely, with both low, average and high mayor's attitude toward initiating, mobilizing and strengthening partnerships, the moderating effect of the mayor's attitude toward involving stakeholders in the local development management process is of the same nature).

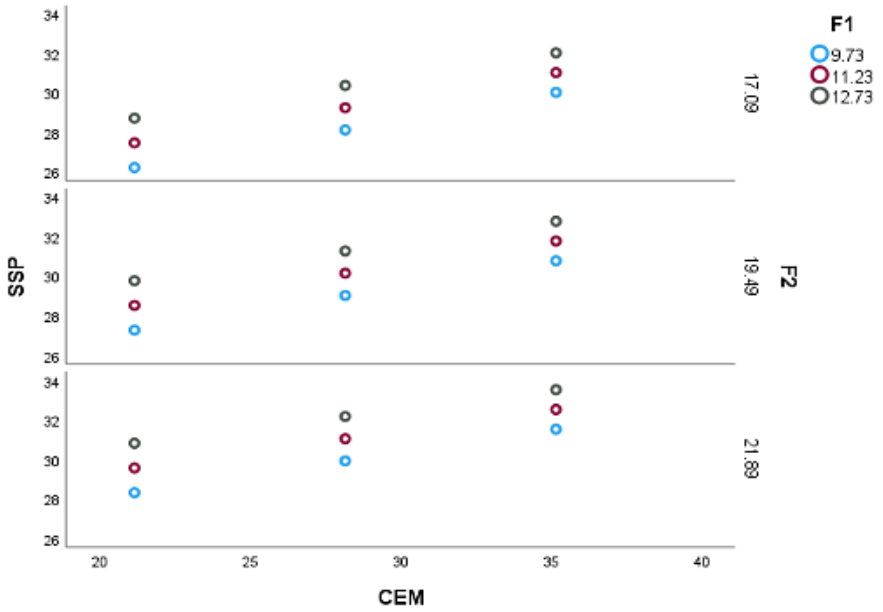

Figure 4. The moderator effect of Mayor's Attitude Toward Cooperation (F1 & F2) in the relations between the Municipality's Involvement in Cooperation (CEM) and Prioritization of Sustainable Smart Growth Challenges (SSP).

Source: own elaboration.

5. Discussion

The findings of our research have led to several significant preliminary conclusions. First, the capacity of Polish local authorities to develop collaborative, inclusive governance is considerable, which should facilitate the creation of more equitable and inclusive municipalities. According to Hambleton (2015) cities that implement policies that are conducive to the environment and also beneficial to residents, while embracing diversity, are able to guarantee equity, inclusiveness, and sustainability. A local leader in such a city should serve as a facilitator, orchestrating the efforts of numerous local actors to construct a just city and collaborating with stakeholders. The high capacity for collaborative, inclusive governance in the surveyed sample of municipalities is determined by the attitudes of mayors toward cooperation. The mayors in this sample are generally open and ready to include various stakeholder groups in local policy-making. They also recognize the need to build and strengthen local partnerships, although this recognition is somewhat less pronounced. The lowest percentage of mayors indicated that they perceived the need to include ethnic and minority groups in decision-making on municipal issues. This is likely due to the low participation or absence of such groups in the populations of the surveyed municipalities at the time of the survey. It is important to note that this situation underwent a significant transformation following the outbreak of the war in Ukraine.

The ability of local authorities to develop collaborative, inclusive governance also stems from municipalities' involvement in cooperation with various stakeholders. Other researchers have indicated that collaborative ventures confirm the municipality's ability to seek external partners (Tuurnas et al., 2019), the ability to establish and manage relationships with partners (Blomqvist, Levy, 2006), as well as learning from shared experiences and transferring that knowledge to subsequent collaborative ventures (Ulbrich et al., 2009). The findings of our research demonstrate that Polish municipalities engage in substantial collaboration with external stakeholders, particularly with local non-governmental organizations (NGOs), local action groups, residents' groups, and local entrepreneurs. It is noteworthy that the majority of the municipalities' cooperation is with local stakeholders, rather than with entities of a supra-local nature or inter-organizational networks. These include, for example, universities, experts, national NGOs, business networking institutions, and business environment institutions. To some extent, this is determined by laws that require municipalities to cooperate with local actors, e.g. in the formula of consultation with residents and with NGOs. Additionally, regulations exist that encourage Polish municipalities to foster collaborative relationships with residents, groups of residents, and NGOs by granting municipalities the right to adopt a civic budget or village funds (rural municipalities). Cooperation with expert entities and inter-organizational networks is not explicitly supported by local government law. The diverse nature of cooperation among Polish municipalities can also be linked to organizational culture. The organizational culture in Polish local government is dominated by clan and hierarchical characteristics, and only marginally manifests adhocracy characteristics (Podgorniak-Krzykacz, 2021). This configuration indicates that conditions are favorable for initiating and conducting cooperative ventures with local stakeholders. However, conditions are unfavorable for experimentation and generating innovations, which require cooperation with support networks and expert organizations. In contrast, research (Springer et al., 2020) conducted in rural municipalities of the Wielkopolska region indicates the dominance among leaders of transactional leadership, which, according to the authors, is associated with the use of only basic forms of participation of residents in local governance, resulting from legislation.

In our analysis, the independent variable we looked for as a determinant was mayors' prioritization of the challenges of sustainable, smart growth. The literature indicates that the transition to sustainable development requires local leaders who are aware of contemporary challenges, which is the starting point for implementing sustainable development policies and initiatives (Alshumrani et al., 2018; Boguszewski et al., 2023; Przywojska et al., 2019; Wittmayer et al., 2016; Wolfram et al., 2016). Also, the motivation of local actors and their goal orientation matters for the results of digital projects (Akterujjaman et al., 2022). In the sample analyzed, prioritization of sustainable smart growth is at a moderately high level. Higher priority was assigned by mayors to economic and social challenges than to environmental challenges. The lowest priority was given to the challenges of digitization and developing smart cities, as well as improving the integration of minorities and emphasizing

diversity and tolerance in the local community. In a recent survey on this topic conducted by Boguszewski et al. (2023), similar results were obtained among local governments of different types (provinces, counties, municipalities) (local governments attach the most significant importance to the socio-economic aspects, environmental issues, but to a small extent to low-emission transport or green building and equality aspects). Thus, the configuration of local development priorities in Polish municipalities still indicates a preference for traditional, established paths of sustainable transformation over more progressive ones and mayors' understanding of sustainable development is not always comprehensive and all-encompassing.

The correlation and regression analyses conducted in this article confirm the impact of municipalities' capacity for collaborative, inclusive governance (both municipal attitudes toward cooperation and its two components, as well as municipality's involvement in cooperation) on mayors' prioritization of sustainable, smart growth challenges. Consequently, it can be concluded that the attitudes of mayors who are open to cooperation, as well as the municipality's involvement in cooperation itself, allow mayors to perceive diverse perspectives and to learn from partners, which in turn directs local policies towards sustainable, smart growth. These findings support the conclusions of other researchers about the importance of municipality's involvement in cooperation for implementing sustainable development practices (Swann, 2017), the role of municipalities' collaboration with residents and local support networks for improving sustainability initiatives (Hawkins, Wang, 2012), the importance of a mayor's conciliatory leadership style for policy agendas that promote an inclusive and equitable city (Umberto et al., 2016), as well as the design and implementation of smart cities and villages (Broccardo et al., 2019).

Our analysis further showed that Mayors' Attitude Toward Cooperation moderates the relationship between Municipality's Involvement in Cooperation and Mayors' Prioritization of Sustainable, Smart Growth Challenges. Considering both components of the Mayor's Attitude Toward Cooperation (F1 - the mayor's attitude toward including stakeholders in the local development management process, F2 - the mayor's attitude toward initiating, mobilizing and strengthening partnerships), we confirmed a stronger moderating effect for the mayor's attitude toward including stakeholders in the local development management process. Identifying an increase in the degree of explanation of the variability of the prioritization of sustainable, smart development challenges as a result of the inclusion of the moderator helped clarify the interplay of the individual and organizational dimensions of collaborative, inclusive governance on mayors' prioritization of sustainable, smart development challenges.

The moderating effect identified is surprising. The higher the mayor's cooperative attitude is, the lower the effect of the municipality's involvement in cooperation on the prioritization of sustainable, smart development challenges, and conversely, when the mayor's cooperative attitude decreases, the prioritization of sustainable development challenges is accompanied by a higher level of cooperation between the municipality and stakeholders. Thus, on this basis, it can be concluded that the importance of cooperation projects (organizational experiences) for

the mayor's adopted development priorities decreases as the mayor's willingness to cooperate (personal beliefs of the leader) increases. The importance of organizational experiences of cooperation for the prioritization of sustainable growth challenges increases as the mayor's attitude towards cooperation (the leader's personal beliefs) decreases.

Thus, our research shows that past cooperative ventures enable municipalities to learn and influence the determination of preferred transit paths to sustainable development, at the same time, the role of past experiences for learning is less than the attitudes and beliefs of the leader, when these are largely oriented towards cooperation. This result can be explained by the predominance of cooperation of the surveyed municipalities with local actors (residents, entrepreneurs, NGOs) over cooperation with organizations with a broader scope and more expert nature of activity (experts, universities, business environment institutions, economic self-government, NGOs with national scope of activity). Although the latter are not a homogeneous category, they share some characteristics. They certainly integrate knowledge, have broader visions of transformation and experience in building partnerships, which may translate into a greater importance of working with them for learning communities and the development of sustainable, smart transit paths. In particular, the support of such actors is essential to integrate and mediate between different local policy interrelations or to define and design the digital and green development (ecosystems, biodiversity) of municipalities (Ferraris et al., 2018; Jayasena et al., 2019; Ugolini et al., 2018). A study conducted by Soberón et al. (2023) on the support of the municipality of Madrid in the operationalization of transition initiatives by the Center for Innovation and Technology for Development of the Technical University of Madrid (itdUPM), confirms the important role of this type of specialized organization in supporting municipalities in developing the capacity to collaborate and manage a sustainable transition On the other hand, an explanation for these correlations can be found on the side of mayors' attitudes towards cooperation, and in particular the somewhat lower declared support of mayors for the involvement of ethnic and minority groups and socially excluded groups in the creation of local policies or in the building of local partnerships. This may suggest that the smaller and less inclusive (and therefore including fewer perspectives) the mayor's attitude towards cooperation, the less important it is for the mayor to adopt sustainable inclusive development priorities.

6. Conclusions

The results of the survey presented in this article provide a deeper insight into the relationship between collaborative, inclusive governance, as manifested in the degree of municipal involvement in stakeholder cooperation and local leaders' attitudes toward cooperation, and the mayor's prioritization of sustainable, smart growth challenges. Based on

the results of surveys conducted in 1,236 municipalities in Poland, we confirmed the existence of a relationship between municipal involvement in collaboration and the prioritization of sustainable, smart growth challenges, as well as between municipal attitudes toward cooperation and the prioritization of sustainable, smart growth challenges. Greater capacity for collaborative, inclusive governance fosters mayors' more comprehensive perceptions of sustainability challenges. We further demonstrate that attitudes toward collaboration moderate the relationship between municipal engagement in collaboration and the prioritization of sustainable, smart growth. Our survey results shed new light on this relationship. They captured that the importance of personal factors, mayors' attitudes, and their willingness to cooperate for adopted local policy priorities is particularly high under conditions of low municipal involvement in cooperation networks. Thus, we confirm the significant impact of the local leader's beliefs on the municipality's entry into the path of transition to sustainable, smart development. When the mayor's collaborative mindset is low, the role of the municipality's engagement with stakeholders, and thus the role of the mayor's administrative background experience in prioritizing sustainable development challenges, increases. The importance of institutional factors in determining the preferred path of the municipality's transformation thus increases The predominance of personal over organizational factors in the mayor's determination of development priorities in a situation of high declarative openness to cooperation is explained by the nature of past cooperation. We found a significantly larger scale of cooperation between municipalities and local actors than with supra-local and expert actors. In addition, the smaller the scale of cooperation, the more it is limited to traditional local actors (residents, NGOs), which may have an impact on its lower importance for prioritizing sustainable smart growth than in the case of expanding cooperation with expert partners.

Based on these results, a recommendation can be made to expand municipal cooperation into partnerships with supra-local expert actors with broader resources, skills, knowledge, and visions, in order to improve the effectiveness of municipal collaborative learning and to transfer this experience to cooperation with traditional actors (e.g. residents), and consequently to adopt sustainable and smart transformation pathways. Collaborative ventures with such actors can be educational, training, experimental, and address transformations towards sustainability.

The results presented also highlight the importance of the mayoral candidate selection process in local elections and the role of residents who are aware of current local challenges. Through the electoral process, residents appoint their representative to the position of mayor, and the selection of a candidate with a consensual attitude, open to dialogue and cooperation, according to our survey results, should contribute to the formulation of local policies with a greater focus on sustainable and smart development. These survey results point to the need to educate residents about the challenges of sustainable and smart development and to influence the topics of debate during the municipal election campaign period.

Our analysis has several limitations. First, we do not take into account other factors that may determine local policy priorities, such as the ability to obtain funding for sustainable development and smart community development projects. Future analyses should therefore also consider the importance of financial factors in the priorities adopted by mayors. Second, our research is limited to an analysis of priorities and does not take into account completed sustainable smart community projects. This approach does not allow us to draw conclusions about the importance of mayors' attitudes towards and involvement in cooperation for real progress in the transition to sustainable smart development.

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"RETHINK AND USE PRODUCT SMARTER" – SUSTAINABLE, CIRCULAR BEHAVIOR OF SILVER CONSUMERS IN POLAND

Justyna PRZYWOJSKA[1*], Aldona PODGÓRNIAK-KRZYKACZ[2], Magdalena KALISIAK-MĘDELSKA[3]

[1] University of Lodz, Faculty of Economics and Sociology; justyna.przywojska@uni.lodz.pl, ORCID: 0000-0002-1125-2225
[2] University of Lodz, Faculty of Economics and Sociology; aldona.podgorniak@uni.lodz.pl, ORCID: 0000-0003-0029-0418
[3] The President Stanislaw Wojciechowski Calisia University, Faculty of Social Sciences; m.kalisiak-medelska@uniwersytetkaliski.edu.pl, ORCID:0000-0002-8701-9411
* Correspondence author

Purpose: The aim of the article is to assess the attitudes of individuals aged 55+ in Poland towards responsible consumption and to identify circular, sustainable behaviors among this demographic, focusing on smart product use through Rethink strategies. These actions are undertaken in response to environmental challenges and the problem of excessive waste production.
Design/methodology/approach: The study employed the CATI (Computer-Assisted Telephone Interviewing) method among residents of Poland aged 55+. The sample was selected considering respondents' gender, age, and place of residence (city or rural area). The research was conducted in 2022.
Findings: The results of the study allow for the formulation of general conclusions regarding the pro-environmental attitudes of individuals aged 55+ and provide answers to the research questions posed.
Social implications: Identification and development of pro-environmental awareness among older adults, as well as strengthening behaviors within the framework of conscious consumption.
Originality/value: Filling the knowledge gap regarding circular behaviors of the Rethink type among older adults aged 55+. The considerations contribute to the discussion on circular behaviors of older individuals.
Keywords: silver economy, sustainable consumption, silver consumers, circular behaviour, strategy Rethink.
Category of the paper: research article.

1. Introduction

The challenge of demographic transition is currently affecting many countries in the EU, including Poland. Demographic transition is a result of persistently low fertility rates and increasing life expectancy, which results in an aging population (Li et al., 2019; Podgórniak-Krzykacz, Przywojska, Warwas, 2020; Podgórniak-Krzykacz, Przywojska, Wiktorowicz, 2020a; Zhang et al., 2021). The share of people aged over 65 in the total EU population will grow by 2050 from 17% to 30% (Podgórniak-Krzykacz, Przywojska, Wiktorowicz, 2020b). The population of Poland will also become increasingly older; by 2060, the number of individuals over 60 in Poland is expected to rise by 21.0% compared to 2022, reaching 11.9 million seniors, which will account for 38.3% of the total population (Główny Urząd Statystyczny, 2023). This trend necessitates an urgent reorganization of living conditions, the local environment, social services, and the adaptation of product and service offerings to make them more friendly for the elderly (Fulmer et al., 2020; Hoof, Marston, 2021; Kowalczyk-Anioł et al., 2021).

At the same time, scientists and international organizations emphasize the importance of taking action for social inclusion and environmental protection in line with the concept of sustainable development. The pursuit of sustainable development has also become a goal of the age-friendly cities movement. The WHO, as the originator of the age-friendly cities concept, emphasizes the importance of sustainable development within the local environment. An environment better adapted to the needs of older adults should also provide broader benefits for the entire community, including the advantages of sustainable development (Hoof, 2023; van Hoof et al., 2024; WHO, 2018).

At the same time, individual consumer attitudes and behaviors are crucial in the pursuit of sustainable development (Oosterveer, Spaargaren, 2013). Sustainable consumption is significant for ensuring both social and environmental sustainability (Vargas-Merino et al., 2023). Among sustainable consumer behaviors aimed at minimizing their negative environmental impact, three main groups can be distinguished: choosing sustainable options (organic and eco-friendly products, as well as local goods and environmentally friendly packaging), avoiding the purchase of new products (circular practices and recommerce, purchasing second-hand items, or participating in the second-hand market), and supporting collective actions (group purchasing, social initiatives within the sharing economy, and borrowing) (Bi et al., 2024).

The first group of behaviors, which involves choosing sustainable products and packaging, is widely discussed in the literature. However, significantly less attention has been paid to consumer attitudes and behaviors aimed at avoiding the purchase of new products and reducing waste generation through circular practices. Researchers emphasize that the circular behaviors of individuals contribute to increasing resource efficiency and reducing waste. These behaviors

align with the circular economy, which promotes sustainable development and has a strong potential to transform society towards a more sustainable future by extending the life cycle of products and encouraging responsible consumption (Ma et al., 2021). Responsible consumption involves conscious and rational resource consumption that seeks to mitigate the negative environmental impact by preventing environmental degradation (Jain et al., 2023; Jiang et al., 2024). Responsible consumption has many dimensions. It can be considered as sustainable, ethical, rational, local consumption, as well as a lifestyle defined as minimalism.

Circular behaviors help reduce the use of new products by extending the usefulness of those already in use. Ali and Choe(2022) categorized the following circular behaviors: Care – maintaining and repairing products, Upgrade – improving the functionality and aesthetics of products to extend their lifespan and reduce the need for purchasing new ones; Repurpose – reusing unused products (through selling, giving away, or applying them in new ways); Appreciate – using the product one already owns and resisting the urge to discard it due to psychological obsolescence.

Currently, we also have several Frameworks R that comprehensively classify circular behaviors. These are sets of strategies that indicate how to achieve a circular economy. These frameworks are useful for both researchers and businesses to understand the pathways to a circular economy. One of the more developed frameworks, the Framework 9R, lists ten circular economy strategies, starting from the "Refuse" (R0) strategy to "Recover" (R9), showing different levels of priority in waste management and the associated circular behaviors (Kirchherr et al., 2017; Potting et al., 2017). At the top of the hierarchy, and thus the most prioritized, are Refuse (R0), Reduce (R2), and Rethink (R3), which focus on smarter and more sustainable practices in the production and use of products. The strategies Reuse (R4), Repair (R5), Refurbish (R6), Remanufacture (R7), and Repurpose (R8) aim to extend the lifespan of products and their parts. For the useful application of materials, the strategies Recycle (R8) and Recover (R9) are highlighted.

In our article, we focus on the circular behaviors of seniors related to smarter product use through the Rethink strategy. This strategy is one of the priority strategies in the Framework 9R and pertains to consumers. It encourages them to share products with each other to maximize their usage and suggests reconsidering how products are used and disposed of. Consumer behaviors associated with the "Rethink" strategy include, among others, borrowing, renting, and sharing products.

The main aim of this article is to assess the attitudes of individuals aged 55+ in Poland towards responsible consumption and to identify circular, sustainable behaviors among this demographic, focusing on smarter product use through the Rethink strategy, undertaken in response to environmental issues and excessive waste production. We focused on older consumers for several reasons. Firstly, the dynamic aging of the Polish population means that seniors represent a significant consumer segment. Secondly, studies on consumer behavior throughout the lifespan are becoming increasingly popular as the number of consumers aged

55+ steadily increases (Carpenter, Yoon, 2015; Venn et al., 2017). Thus, we contribute to the ongoing discussion on consumer behaviors among older adults. Thirdly, we fill the gap in knowledge regarding Rethink-type circular behaviors. Existing research has not addressed this issue. Few studies to date have focused on responsible and sustainable consumption among mature adults (Grasso et al., 2019; Zbuchea et al., 2021) or responsible consumption in a broader - generational – context (Bulut et al., 2017; Diprose et al., 2019; Gordon-Wilson, Modi, 2015; Morrison, Beer, 2017; Pinto et al., 2011). On the other hand, studies concerning older adults in Poland have focused on assessing the environmental awareness of seniors (Ministerstwo Klimatu i Środowiska, 2020; Włodarczyk, 2019) and identifying sustainable shopping behaviors (Zalega, 2018, 2024). Fourthly, understanding consumer behaviors in relation to R-strategies is, according to researchers (Zimmermann et al., 2024), essential for businesses to adjust their marketing strategies to meet the needs and preferences of consumers, and ultimately to ensure the successful adoption of a circular economy.

In the article, we present the results of representative research among Polish consumers aged 55 and older. The study allowed us to answer the following research questions:

1. What environmental problems are considered the most burdensome by individuals aged 55+?
2. What is the attitude of individuals aged 55+ towards responsible consumption?
3. To what extent do individuals aged 55+ use products in a smarter way, applying the Rethink strategy?

2. Methods

In order to answer the research questions, we conducted a study using the CATI technique among 401 individuals aged 55+ in Poland. The research sample was selected proportionally from the population living in Poland aged 55+, taking into consideration gender, age, as well as the voivodeship where they live and the respondents' place of residence (i.e. the city or the village). The study was conducted in 2022. The study included control variables such as gender, place of residence (city, village), and income per person in the household.

Table 1.
Sample structure

Variable		N	%
Gender	Men	171	42.6
	Women	230	57.4
Place of residence	Village	138	34,4
	City	263	65,6
Income	2000 PLN or lower	246	61.3
	2001-3000 PLN	115	28.7
	3001-4000 PLN	32	8.0
	over 4000 PLN	8	2.0

In the study, we defined three variables:

1. The perception of environmental problems by individuals aged 55+
2. The attitude of individuals aged 55+ toward responsible consumption
3. Smarter product use – Rethink behaviors among individuals aged 55+

The measurement of variable (1) Perception of environmental problems by individuals aged 55+ involved respondents identifying the most burdensome environmental issue from five options: air pollution; overcrowded landfills, waste management problems; water pollution; climate change; and depletion of natural resources.

Variable (2) Attitude of individuals aged 55+ toward responsible consumption was measured using 3 items that assess the frequency with which respondents follow the following principles:

Table 2.
Measurement of the variable Attitude toward responsible consumption

Variable	Items	Scale
Attitude toward responsible consumption	I follow the principle of making products myself rather than purchasing them	Always Often Sometimes Never
	I adhere to the principle of renting or exchanging (e.g., books, equipment/ tools) instead of buying	
	I apply the principle of minimalism, purchasing only necessary items and avoiding unnecessary ones	

Source: own elaboration.

The variable (3) Smarter product use - Rethink behaviors among individuals aged 55+ was measured using four items assessing the frequency of the following practices:

Table 3.
The measurement of the variable Smarter product use – Rethink behaviors

Variable	Items	Scale
Smarter product use – Rethink behaviors	I give away unused products to other people	Always Often Sometimes Never
	I sell my clothes and equipment online on platforms such as OLX.pl, Vinted.pl, and Allegro.pl	
	I willingly borrow items from others that I only need occasionally	
	I purchase products jointly with friends or family to share their use afterward	

Source: own elaboration.

In the Research results section, we present the distribution of responses from the respondents and their average ratings, taking into account respondent characteristics such as gender, place of residence, and income per person in the household. The average ratings were calculated for the components of variable (2) Attitude toward responsible consumption and (3) Smarter product use – Rethink behaviors. The scale was coded as follows: 1 – always, 2 – frequently, 3 – sometimes, 4 – never. Therefore, the lower the average rating, the more frequently respondents engage in the behavior.

3. Research results

3.1. Perception of environmental issues among individuals aged 55+ in Poland

The majority of respondents (44.4%) identified air pollution as the most critical environmental problem (Table 4, Figure 1). The second most frequently indicated issue was water pollution, with 19% of responses, representing less than half the number of mentions for air pollution. Approximately one-sixth of respondents highlighted overfilled waste landfills and climate change as key concerns. The prioritization of air pollution may be influenced by its frequent coverage in the media. Additionally, air pollution constitutes a significant health hazard for older adults, who are disproportionately affected by its adverse effects (D'Oliveira et al., 2023).

Table 4.
The most pressing environmental issues according to respondents

Problems	n	%
Air pollution	178	44,4
Overfilled waste landfills, waste management issues	66	16,5
Water pollution	76	19,0
Climate change	61	15,2
Depletion of natural resources	20	5,0
Total	**401**	100,0

Source: own elaboration.

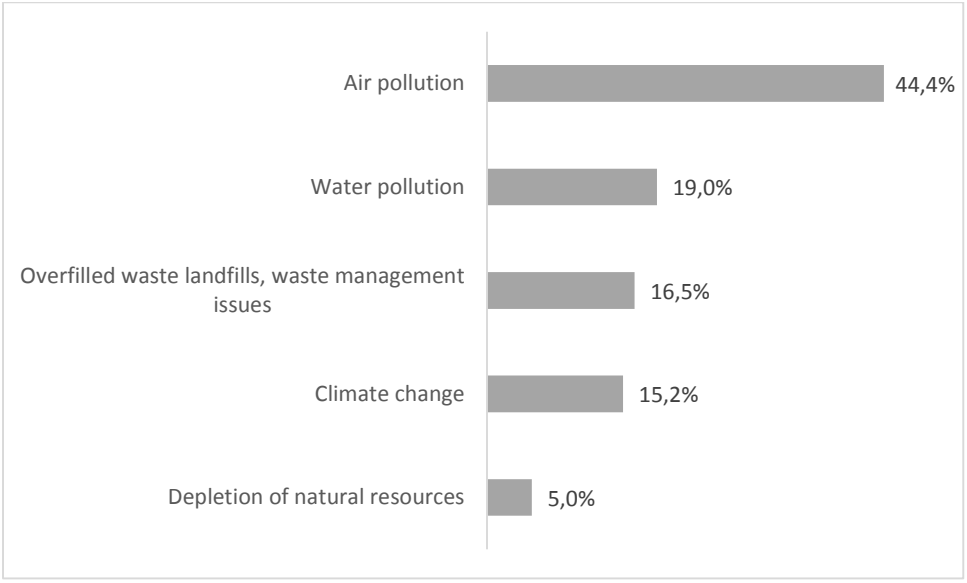

Figure 1. Ranking of the most pressing environmental issues according to respondents.
Source: own elaboration.

Comparing the responses of women and men (Table 5), it can be observed that women more frequently than men identified air pollution, water pollution, and climate change as the most burdensome problems. In contrast, men more often than women emphasized issues related to waste generation and management.

Table 5.
The most pressing environmental issues by gender of respondents

Environmental issues	Gender					
	Women			Men		
	n	%	rank	n	%	rank
Air pollution	105	45,7	1	73	42,7	1
Overfilled waste landfills, waste management issues	35	15,2	4	31	18,1	2
Water pollution	46	20,0	2	30	17,5	3
Climate change	37	16,1	3	24	14,0	4
Depletion of natural resources	7	3,0	5	13	7,6	5
Total	230	100,0	-	171	100,0	-

Source: own elaboration.

Respondents living in rural areas more frequently than those residing in urban areas identified water pollution as the most burdensome environmental issue (Table 6). Conversely, city dwellers were more likely to point to air pollution and climate change as the most pressing problems.

Table 6.
The most pressing environmental issues by respondents' place of residence

Environmental issues	Place of residence					
	Village			City		
	n	%	rank	n	%	rank
Air pollution	58	42,0	1	120	45,6	1
Overfilled waste landfills, waste management issues	23	16,7	3	43	16,3	3
Water pollution	32	23,2	2	44	16,7	2
Climate change	19	13,8	4	42	16,0	4
Depletion of natural resources	6	4,3	5	14	5,3	5
Total	138	100,0	-	263	100,0	-

Source: own elaboration.

Considering the respondents' income levels (Table 7), it can be observed that individuals with incomes of up to 2000 PLN per capita in the household more frequently than wealthier respondents identified air pollution as a pressing issue. Respondents with incomes in the range of 2001-3000 PLN stood out with regard to concerns about overcrowded landfills and waste management, with this issue ranking as the second most significant in this group. Meanwhile, respondents with incomes between 3001-4000 PLN more frequently than other income groups highlighted the depletion of natural resources as a key environmental concern. Respondents earning over 4000 PLN, although constituting a small proportion of the sample (8 individuals), were more likely to emphasize the severity of water pollution and climate change issues compared to less affluent respondents.

Table 7.
The most pressing environmental issues by respondents' income

Environmental issues	Income per capita in the household (PLN)											
	2000,00 or lower			2001,00–3000,00			3001,00-4000,00			over 4000,00		
	n	%	rank	n	%	rank	n	%	rank	n	%	rank
Air pollution	114	46,3	1	48	41,7	1	13	40,6	1	3	37,5	1
Overfilled waste landfills, waste management issues	32	13,0	4	27	23,5	2	6	18,8	2	1	12,5	4
Water pollution	47	19,1	2	21	18,3	3	6	18,8	2	2	25,0	2
Climate change	40	16,3	3	16	13,9	4	3	9,4	5	2	25,0	2
Depletion of natural resources	13	5,30	5	3	2,6	5	4	12,5	4	0	0,0	5
Total	246	100,0	-	115	100,0	-	32	100,0	-	8	100,0	-

Source: own elaboration.

3.2. Attitudes of individuals aged 55+ toward responsible consumption

The attitudes of individuals aged 55+ toward responsible consumption, as reflected in the results of our study, appear to be quite positive. Nearly 60% of respondents always or frequently adhere to the principle of producing goods themselves rather than purchasing them (Table 8). The remaining 40% follow this principle occasionally. The principle of renting and exchanging products instead of purchasing them is somewhat less prevalent, with just over half of respondents always or frequently adopting this principle. The principle of minimalism is always or frequently practiced by 49.10% of respondents, although the highest proportion, 11%, reported never adhering to it.

Table 8.
Respondents' attitudes toward responsible consumption

Attitudes	Frequency	n	%
I follow the principle of making products myself rather than purchasing them	Always	57	14,2
	Often	180	44,9
	Sometimes	158	39,4
	Never	6	1,5
I adhere to the principle of renting or exchanging (e.g., books, equipment/tools) instead of buying	Always	35	8,7
	Often	180	44,9
	Sometimes	173	43,1
	Never	13	3,2
I apply the principle of minimalism, purchasing only necessary items and avoiding unnecessary ones	Always	28	7,0
	Often	169	42,1
	Sometimes	160	39,9
	Never	44	11,0

Source: own elaboration.

An analysis of the respondents' average ratings indicates that women adhere to the above principles slightly more often than men, and individuals living in cities more frequently than those in rural areas (Table 9). Considering respondents' income levels, those with the highest incomes, above 4000 PLN, were less likely than others to follow all the principles, particularly the principle of minimalism.

Table 9.
Average ratings of attitudes toward responsible consumption among individuals aged 55+ by gender, place of residence, and income levels

Attitudes	Gender		Place of residence		Income per capita in the household (PLN)			
	Women	Men	Village	City	2000,00 or lower	2001,00-3000,00	3001,00-4000,00	over 4000,00
I follow the principle of making products myself rather than purchasing them	2,20	2,39	2,30	2,27	2,33	2,17	2,28	2,38
I adhere to the principle of renting or exchanging (e.g., books, equipment/tools) instead of buying	2,33	2,51	2,50	2,36	2,45	2,30	2,41	2,75
I apply the principle of minimalism, purchasing only necessary items and avoiding unnecessary ones	2,45	2,68	2,60	2,52	2,63	2,35	2,47	3,13

Source: own elaboration.

3.3. "Rethink" behaviors among individuals aged 55+

The "Rethink" behaviors analyzed in the study most often involve respondents giving away unused products to others (Table 10). This is always practiced by 6% of respondents, with an additional 43.4% doing so frequently. The second most common Rethink behavior, in terms of frequency, is purchasing products jointly with friends or family to share their use. Only 2.7% of respondents reported always engaging in this practice, while 35.4% do so frequently. Borrowing items from other people is most commonly done occasionally, with 52.6% of respondents indicating this frequency. Conversely, the behavior of selling their clothes and equipment online through platforms such as OLX, Vinted, or Allegro recorded the highest percentage of "never" responses (76.8%).

Table 10.
Frequency of "Rethink" behaviors among respondents

"Rethink" behaviors	Frequency	n	%
I give away unused products to other people	Always	24	6,0
	Often	174	43,4
	Sometimes	154	38,4
	Never	49	12,2
I sell my clothes and equipment online on platforms such as OLX.pl, Vinted.pl, and Allegro.pl	Always	0	0,0
	Often	28	7,0
	Sometimes	65	16,2
	Never	308	76,8
I willingly borrow items from others that I only need occasionally	Always	8	2,0
	Often	112	27,9
	Sometimes	211	52,6
	Never	70	17,5

Cont. table 10.

I purchase products jointly with friends or family to share their use afterward	Always	11	2,7
	Often	142	35,4
	Sometimes	186	46,4
	Never	62	15,5

Source: own elaboration.

Women slightly more frequently than men declare engaging in all of the discussed Rethink behaviors (Table 11). There are no significant differences in the frequency of these behaviors between urban and rural residents. Meanwhile, individuals with the highest incomes engage in all the discussed behaviors less frequently than respondents with lower incomes.

Table 11.
Average frequency of "Rethink" behaviors among respondents by gender, place of residence, and income level

"Rethink" behaviors	Gender		Place of residence		Income per capita in the household (PLN)			
	Women	Men	Village	City	2000,00 or lower	2001,00-3000,00	3001,00-4000,00	over 4000,00
I give away unused products to other people	2,55	2,6	2,5	2,60	2,58	2,51	2,63	2,75
I sell my clothes and equipment online on platforms such as OLX.pl, Vinted.pl, and Allegro.pl	3,67	3,73	3,69	3,70	3,72	3,66	3,66	3,88
I willingly borrow items from others that I only need occasionally	2,81	2,92	2,85	2,86	2,91	2,77	2,72	3,00
I purchase products jointly with friends or family to share their use afterward	2,70	2,81	2,76	2,74	2,76	2,74	2,63	2,88

Source: own elaboration.

4. Discussion and conclusion

The Rethink behaviors analyzed in our study among Poles aged 55+ are undertaken by respondents with moderate frequency. Particularly rarely practiced is the sale of their own clothes and equipment on online platforms such as olx.pl, vinted.pl, and allegro.pl. This may be hindered by lower digital competencies of older adults in Poland, as pointed out by other researchers(Garwol, 2019; Susło et al., 2019). On the other hand, respondents in our study recognize the burden of environmental problems. The most pressing issues they highlight are air pollution, water pollution, and overcrowded landfills. These problems significantly determine the quality of life for older adults, who are one of the groups particularly vulnerable to the negative consequences of such threats (e.g., the increased mortality of older adults due to diseases resulting from poor air quality) (Michalak et al., 2022).

Existing studies indicate that women tend to have stronger pro-environmental attitudes than men. They are significantly more likely to engage in various environmental activities (Tindall et al., 2003; Zelezny et al., 2000). Our research findings also confirm that women aged 55+ are more sensitive to the issue of climate change. They are more concerned than men about the ongoing degradation of the natural environment (air pollution, water pollution). Women are slightly more likely than men to adhere to the principles of responsible consumption. They are more inclined to produce goods (such as food or clothing) themselves rather than purchasing them. These attitudes are not solely a result of disposable income, but also influenced by trends, the desire to stand out, or social sensitivity (e.g., donating clothing to those in need). For women, emotional and sentimental values attached to goods are also important. However, women engage in Rethink circular behaviors with the same, equally low frequency as men.

Men, as respondents in our study, similarly to women, recognize the importance of environmental issues, although they attach more significance to the problem of waste. Like women, they also follow the principles of responsible consumption. They see the rationale in producing goods themselves or sharing products. However, it is difficult to clearly observe a connection between circular behaviors and gender, as indicated by other researchers (Bassi, 2023; Patel et al., 2017).

An important variable influencing pro-environmental behaviors is income, as it is a key factor determining purchasing power. For most older adults, the primary source of income is pensions, which are typically allocated to meet basic needs. As highlighted in the Green Generation report (Mobile Institute, 2020), there is a common belief among individuals aged 55+ that living according to ecological principles involves additional costs.

Interestingly, the results of our study indicate that respondents with relatively high incomes (above 4,000 PLN) are less likely to follow the principles of responsible consumption in their consumer choices. They apply the principle of minimalism to the least extent. On the other hand, individuals with lower incomes are more inclined to produce goods themselves or share items (such as tools, devices, books, etc.) with others. For Polish seniors, such behaviors may stem from habits acquired in the past, personal experiences, or values passed down from their families. Thus, some circular behaviors seem to be "inherited" from generation to generation rather than the result of ecological awareness development. On the other hand, these behaviors could also have an economic basis. As indicated by the report on the economic security of households in Poland (Derkacz et al., 2024), seniors, compared to other age groups, assess their ability to engage in current consumption less favorably. Their incomes often do not allow them to achieve financial stability. The lack of sufficient financial resources to meet basic needs limits the tendency to waste resources and forces a more rational approach to their use. Younger generations entering retirement carry with them consumption behaviors and habits shaped in market economy conditions. These behaviors are often revised due to a decrease in disposable income.

Considering the criterion of place of residence, our study shows that the ranking of environmental issues is the same for respondents living in rural and urban areas. However, those living in rural areas were more likely to point out water pollution as a major problem. On the other hand, city dwellers are more sensitive to climate change. In cities, especially large ones, a range of phenomena related to air pollution accumulates, such as the urban heat island effect and the lack of biologically active surfaces. These issues have a significant impact on the health of older adults.

Our study focused on the attitudes and pro-environmental behaviors of individuals aged 55+ in Poland, with particular emphasis on the implementation of the "Rethink" strategy within responsible consumption. The research reveals a positive attitude among seniors towards responsible consumption, though it also highlights limitations related to the adoption of more sustainable and digital solutions, such as online sales or shared purchasing. The findings provide valuable insight into the consumer behavior of older adults and indicate the need for educational and systemic support to increase their involvement in circular consumption. Campaigns should emphasize the importance of environmental issues, such as climate change, which, according to our research, are less recognized by individuals aged 55+. Education should also promote "Rethink" behaviors as simple and accessible ways to protect the environment. An important direction for action should also involve promoting local circular economy initiatives, particularly by facilitating access to product exchange and rental platforms. For individuals aged 55+, education regarding sharing, selling, or exchanging goods online is crucial. Future research is also recommended to explore in greater depth the underlying factors influencing the consumer behaviors of older adults.

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DETERMINANTS OF RURAL WOMEN'S ACTIVITY IN NON-GOVERNMENTAL ORGANIZATIONS

Jacek PUCHAŁA

University of Agriculture in Krakow; jacek.puchala@urk.edu.pl, ORCID: 0000-0002-7671-411X

Purpose: The paper analyses factors motivating women to become involved in the activities of Rural Homemakers' Clubs (RHCs) (*Koła Gospodyń Wiejskich*). The articles points to drivers responsible for the involvement of respondents in the activities of the Rural Homemakers' Clubs. It presents activities performed by the surveyed RHCs. The study also presents information about areas in which the Rural Homemakers' Clubs are helpful to their members as well as reasons why some women do not participate in their activities. A ranking of reasons of non-participation in the activities of the organizations such as the RHC was developed. The paper also discusses activities which would be the most useful within the area where the surveyed RHCs function.

Design/methodology/approach: The survey was carried out among the Rural Homemakers' Clubs (KGW) being women's organizations with very few exceptions. In general there are approximately 10,000 entities of that kind operating in Poland. They are registered with the Agency for Restructuring and Modernization of Agriculture (*Agencja Restrukturyzacji i Modernizacji Rolnictwa*) or an agricultural club (*kółko rolnicze*) as associations. There are also organizations that have not been formalized or registered. The purpose of their operations is to cultivate tradition, foster personal development of their members and maintain local recipes. A research sample consisted of 136 RHCs.

Computer aided interview surveys were conducted; surveys were sent by e-mail. A research tool included open-ended and closed-ended questions. Closed-ended questions included answers such as "I definitely disagree" and "I rather disagree" as well as "I rather agree" and "I definitely agree". Crosstabs were prepared for the purpose of developing diagrams.

The following research hypotheses were adopted:

1. leadership in the RHCs should take the form of coaching leadership because personal development was the major motivating factor behind women's involvement in those organizations.
2. In rural areas the factors that push women to participate in the RHCs were: "the need to act", "integration with others" and "interactions with people".
3. Willingness to help others is a factor characteristic of unmarried rather than married people.
4. The need to "go out" is a stronger factor motivating people aged 31-60 compared to other age groups.
5. To the RHC members such membership proves helpful mostly when it comes to social advancement.
6. Failure to accept such activity by life partners is the most important disincentive for people to get involved in the activities in the RHCs.

Findings: People are motivated to become involved in the activities of RHCs partly by selfish motives (access to fairs thanks to the RHCs – 31.6% of respondents, facilitated handicraft sale thanks to the RHCs - almost 35% of respondents, willingness to help oneself – nearly 53% of respondents, personal growth – 74% of respondents). Personal reasons are also altruistic, pro-social (socialization-related), e.g. a desire to help others – nearly 80% of respondents, a desire to pass on one's knowledge – nearly 57% of respondents. The need to team up and work with others is a factor that motivates a similar number of respondents as willingness to network (integrate) – 84.6% and 83.1% of respondents, respectively.
Research limitations/implications: The members of the Rural Homemakers' Clubs are often seniors; frequently they are not Internet users. The respondents' age structure is dominated by the group aged 31 - 50 (32.4% and 41.9% of respondents, respectively). The respondents aged 61+ accounted for approx. 7.5% the research sample. Hence, the research results appear characteristic rather for younger people. In order to obtain answers from elderly members of the RHCs, the survey should have been sent by regular mail.
Originality/value: The article is a new look at the aspect under study and is part of a larger study, the results of which will be presented in subsequent articles.
Keywords: organization networking, *Koło Gospodyń Wiejskich* (Rural Homemakers' Club), motivating factors, development of rural areas, organization networking.
Category of the paper: research paper.

1. Introduction

Personal development and improvement of women's social and professional situation are important factors behind their involvement in organizations. The Rural Homemakers' Club is a voluntary, independent, social and professional organization of women that operates in rural areas. Important factors behind the establishment of women's organizations are political factors, actually the influence of politically active persons on women. The Rural Homemakers' Club in Słobódka Bołszowiecka, which was the first such club in the Polish territory, was established in 1877 in Janisławice by a socialist activist, Filipina Płaskowicka. Therefore, the factors related to the transfer of innovations are crucial. In that case Filipina Płaskowicka acted as such factor, although she was not the one who came up with the model of the Club as an organization because a similar organization called the Association of Homemakers (*Towarzystwo Gospodyń*) operated since 1866 in Piaseczno in the Gdańsk Pomerania.

Women's associations that were established were ancillary to agricultural clubs. Such agricultural clubs were voluntary, social and economic organizations associating farmers and their purpose was to boost and improve agricultural production. Thanks to access to state-of-the-art knowledge in the area of hygiene, health and nutrition, members of female organizations were to support the development of rural communities. In other words, the first women's organizations in rural areas were established partly due to the necessity of convincing wives to let their husbands out of the house to take part in training sessions. Wives discouraged their husbands from participating in agricultural associations as they believed that they spent time there chatting and drinking alcohol. In 1866 Julian Kraziewicz established the

"Association of Homemakers" (*Towarzystwo Gospodyń*) to persuade women that their suspicions towards their husbands were wrong, to present the purpose of the associations and teach women useful homemaking skills.

At present the Rural Homemakers' Clubs mostly cherish local traditions, draw connections to roots, inspire to take action and contribute to building bridges between generations in local communities. They successfully complete local projects, take civic initiatives and perform tasks provided for in the Sołectwo Fund. The Rural Homemakers' Clubs get involved in cultural events organized in gminas (communes), poviats and capitals of voivodeships, including, among other things, harvest festivals or exhibitions of handicrafts. The RHCs cherish local customs, cultivate culture and promote culinary traditions. The Clubs cultivate the traditions of family and neighborly life and keep forgotten local traditions alive. They create amazing handicrafts keeping cultural heritage for future generations. Together with village heads they organize various ceremonies such as harvest festivals, games for children, youth and adults that bring together entire generations. The activities of the RHCs are not just limited to cooking and singing but also include staging theatre performances, doing needlework, making decorations, cultivating local traditions, celebrating religious and other holidays and recovering customs. The Rural Homemakers' Clubs make life in the country more attractive. Despite many socio-cultural changes and ongoing march towards modernity the Rural Homemakers' Clubs have survived, remain faithful to traditions and bravely implement their goals.

Motivation is very important to the organization and refers to forces that determine directions, intensity and duration of human activities. Motivating people to act is not easy, let alone become engaged in social work, hence the idea to research the motivation of women who get involved the activities of the Rural Homemakers' Clubs'. There are numerous theories related to motivation. Maslov's Hierarchy of needs theory (Maslov, 1954; McClelland, 1987) points to the hierarchy of needs from physiological ones to self-fulfillment being the motivating factors. The equity theory or social comparison theory (Adams, 1965) points to a psychological phenomenon of drawing conclusions regarding oneself in terms of comparisons to others (abilities, values, attitudes). According to the expectancy theory (Vroom, 1964), motivation depends on two factors: on how strongly we desire something and on the expected likelihood of fulfilling that desire. A goal-setting theory, a theory of motivation (Locke, Latham, 1990) posits that clear, well-defined and measurable goals improve performance much better than those which are unclear. The Job design model (the job characteristics theory) is a model developed by Richard Hackman and Grieg Oldham (Hackman, Oldham, 1976, 1980) that describes the job whose five basic characteristics include: diversity of skills, task idiopathy, task meaning, independence and feedback. The self-determination theory (Deci, Ryan, 1985; Ryan, Deci, 2000) is based on the assumption that the desire to reach a specific goal is a basic source of motivation. The goal is what we intend to achieve within a specific period of time.

The research into the participation of women in non-governmental organizations discovers several motivating factors, including willingness to make a contribution to the society, acquiring knowledge and skills, networking, increasing career perspectives and building self-esteem. Women are also interested in working for non-governmental organizations because they care about social issues, search for educational experiences, express idealism and appreciate flexibility and independence. The involvement in NGOs may strengthen women's position in economic and social terms, particularly in developing countries where traditional customs frequently make the involvement of women difficult (Panday, 2016). However, challenges such as limited time due to family responsibilities, gender stereotypes, lack of awareness as regards benefits for non-governmental organizations, limited access to information and low self-confidence prevent women's active involvement. Despite those difficulties a growing number of women's NGOs is an indication of growing recognition of women's important role in social growth and their potential to influence politics and the process of solving women's problems.

2. Research sample - description

The majority of the RHCs to which the respondents belonged are registered with the Agency for Restructuring and Modernization of Agriculture (ARMA) (74% of the respondents). The RHCs registered as associations in the National Court Register accounted for 3% and those registered with the Agricultural Club only 1% of the sample. Only 5% of the surveyed RHCs were registered in several registers and only 2% of the respondents specified that their RHC was not registered in any register. 15% of the respondents were unable or did not want to specify the RHC's legal form.

Mostly women are the members of the Rural Homemakers' Clubs but the surveyed sample also included men (approximately 3% - 4 persons). Three fourths of the survey respondents were married. Two thirds of the respondents had higher education (73.5% of the sample), whereas every fifth respondent had secondary education (9.6% graduated from high school and 11.8% were technical secondary school graduates). 4.4% of the respondents had vocational education and 0.7% - primary education.

Regarding the age structure of the respondents, they were mostly people aged 31-50 (32.4% and 41.9% of the respondents). Every tenth respondent was aged 18-30 years old (7.4% of the surveyed RHC members) or 51-60 years old (11% of the surveyed respondents). People aged 61+ accounted for approximately 7.5% of the research sample (Figure 1).

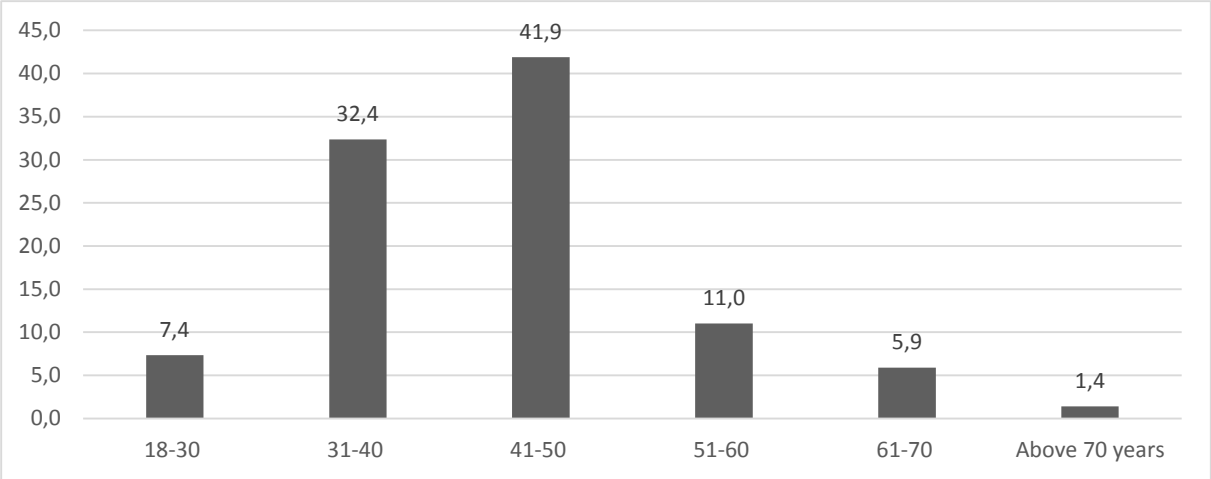

Figure 1. The respondents' age structure (%).

Source: own study based on the interview surveys, N = 126.

Every tenth respondent works on a farm for up to one hour per day (11% of the respondents). Approximately 14% of the respondents spend more than one hour but no more than three hours working on the farm whereas approximately 10% of the respondents work for more than three but no more than five hours. Almost 7.5% of the respondents spend more than five hours working on the farm. In total four out of ten persons devote their time to farm work. The majority of the farms have an area up to 15 ha of utilized agricultural area (66% of the farms – diagram 2). The introduction of agricultural innovations resulted in the decrease of the time women spend working on farms. Women's average farm work time in 1992 per day totaled 6 hours and 30 minutes and in 1996 it was down to 5 hours and 40 minutes, i.e. 50 minutes less over the course of four years. Those calculations result from the subjective assessment made by women surveyed by Ostrowski (1998). The number of farm work hours differs in three different groups of women. The first group consists of persons being in charge of the farm. The second group comprises women helping on farms managed by a man: a husband, a brother or a father. The third group includes women from non-farm families who are housewives and householders.

The research sample mainly included the persons that help on farms run by another person (31.6% of the respondents). The persons running the farm accounted for 15.4% of the respondents. Every fourth respondent came from a non-farm family and was a householder (25.7% of the respondents). Approximately 27% of the respondents stated that they were not closely connected to any of said groups and those were the respondents who, for example, came from a farm family but currently they were not connected to any farm work as, for example, they leased their UAA and changed their career engaging in business activity or non-farm work.

The most frequent non-agricultural profession practiced by the respondents is that related to working in a gmina office (17.6% of the respondents), as a school teacher (9.6% of the respondents) and as sole traders (13.2% of the respondents). Other professions practiced by the respondents included a broad range of specialties, e.g. a food technologist, a forester, a logistic, a kids' animator, a wireman, a social animator, a copywriter, an accountant, an HR manager,

a graphic, a photographer, a postman, a promotion and collaboration specialist, a nurse, uniformed services, a career of the elderly and a product quality controller.

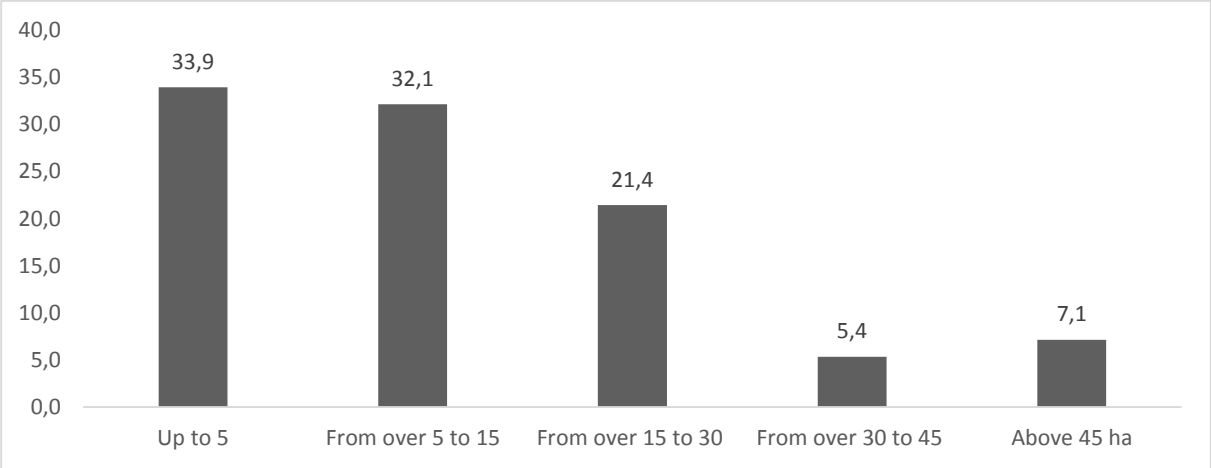

Figure 2. The structure of the size of farms of persons working there (%).

Source: own study based on the interview survey, N = 80.

50% of the surveyed RHCs are engaged in gainful activities (54%). Most frequently such gainful activities involve selling regional foods (18%), folk arts, including folk and artistic handicrafts (approx. 15%) or lease (approx. 10%). 35% of the surveyed RHCs perform registered business activities. The Clubs registered with the Agency for Restructuring and Modernization of Agriculture accounted for over 74% of the surveyed organizations.

Four out of ten surveyed organizations (39% of the respondents) do not team up with other institutions. The remaining 83 clubs mostly work together with other Rural Homemakers' Clubs and Volunteer Fire Brigades (37% responses in each category). Every third RHC works together with a local self-government, most frequently at the gmina level (33% of the respondents) and associations (25% of the respondents), and seldom with foundations (16% of the respondents). Co-operation with self-government mostly refers to co-operation with a gmina or poviat cultural center (20% of the respondents). The surveyed organizations frequently work together with elementary schools (18%), very rarely with universities (2.4%). The RHCs network mostly on a local basis, teaming up with parishes (13% respondents), the Local Action Group (5% of respondents). Individual organizations also worked together with the National Agricultural Support Center (*Krajowy Ośrodek Wsparcia Rolnictwa*), the Agency for Restructurization and Modernization of Agriculture, the National Union of Rural Homemakers' Clubs (*Ogólnopolski Związek Kół Gospodyń Wiejskich*), the Poviat Council of Homemakers' Clubs (*Powiatowa Rada Kół Gospodyń*) as well as local companies. An interesting fact is that the RHCs also stated that they work together with the Social Economy Support Center and Business Incubator.

3. The author's research findings

The interview survey findings were divided into four subchapters. The chapter entitled "Motivation to act in the context of functions resulting from human needs" analyses research results in the context of six functions connected to human needs which volunteer service may potentially meet. That chapter also includes numerous references to source literature. The Rural Homemakers' Club is useful to the respondents and helps implement many interesting initiatives. Those initiatives are described in the chapter entitled "The activity of Rural Homemakers' Clubs and subsidiarity of those organizations to the respondents". The chapter entitled "Factors affecting the activities of women in non-governmental organizations" features a brief history of women in NGOs. That chapter also includes a ranking of reasons for women's non-participation in the RHCs. SWOT analysis of the surveyed organizations developed on the basis of the research is presented at the end of the paper's fourth subchapter.

3.1. Motivation to act in the context of functions resulting from human needs

Each human being has their own life goals linked to their motivation to act as presented by the self-determination theory. To some a goal will consist in developing sales skills and hence their motivation to become involved in the activities of the RHCs will be to improve skills to sell their handicrafts. Motivation to get involved in the RHC stems from personal reasons. It is partially driven by selfish reasons (access to fairs thanks to the RHCs – 31.6% respondents, facilitated sales thanks to the RHCs - almost 35% respondents, willingness to help oneself – almost 53% respondents, personal development – 74% respondents). **Those responses show that hypothesis no. 1 is true, which is also demonstrated by 74% of respondents who have selected personal development as the reason for getting involved in the RHCs.** Personal reasons are also altruistic, prosocial, e.g. a desire to help others – nearly 80% respondents, a desire to pass on one's knowledge – nearly 57% respondents. The need to team up and work with others is a factor that motivates a similar number of respondents as willingness to network – 84.6% and 83.1% of respondents, respectively (Table 1).

Clary et al. (1998) identified six functions resulting from human needs that voluntary service can potentially serve:

1. the function of expressing humanitarian values (Table 1: Item: 3).
2. the function of seeking other's understanding (Table 1: Item: 4,8).
3. the function of benefits related to professional career (Table 1: Item: 9, 15, 16).
4. the function of obtaining protection from feelings, e.g. the sense of guilt that one is more lucky than other people (Table 1: Item: 3, 10).
5. the function enhancing one's self-esteem (Table 1: Item: 1, 7, 11, 12, 14).
6. the function of a desire to fit in or adjust to a group which is important to a community (Table 1: Item: 2, 5, 6, 9, 13).

Based on the above one may conclude that any and all functions proposed by Clary et al. (1998) are reflected in the reality of the functioning of the RHCs. Two functions are very important to the respondents: the enhancement of one's self-esteem (Table 1: Item: 1, 7, 11, 12, 14) and the function related to a desire to fit in or adjust to the group important to the community (Table 1: Item: 2, 5, 6, 9, 13). People who are orientated towards personal development are motivated to get involved in the RHCs due to opportunities to take part in interesting training sessions and activities in order to learn new knowledge and skills. **The above demonstrates that hypothesis no. 1 is true and that leadership in the RHCs should take the form of a partnership**. As regards persons who want to pass on their knowledge to others, their underlying motivation will be an opportunity to be able to present the results of their work and ways to achieve their goals. Such people should be assigned tasks tailored to their needs resulting from motivation behind their involvement in the activities of the RHCs. Persons to whom access to fairs is a vital reason for their membership in the RHCs will be motivated in proportion to the number of business contacts they have established thanks to the RHCs' participation in fairs.

Table 1.
Reasons for the respondents' participation in the activities of the Rural Homemakers' Clubs

Item.	Details	Number	%
1	The need to act	115	84.6
2	Integration with other people	113	83.1
3	Willingness to help others	110	80.9
4	Interaction with other people	110	80.9
5	Willingness to do something with others	109	80.1
6	Meeting with other women	104	76.5
7	Personal development	101	74.3
8	The need to go out	84	61.8
9	Performing a public function facilitates negotiations with representatives of local authorities	83	61.0
10	Willingness to pass on one's knowledge	78	57.4
11	Extending life activities	77	56.6
12	Willingness to help oneself	73	53.7
13	Willingness to do something in one's free time	64	47.1
14	Extending life activities	56	41.2
15	Easier handicrafts sales through the RHCs	48	35.3
16	Access to fairs thanks to the RHCs	43	31.6
17	Other reasons of the respondents' involvement in the RHCs	51	37.5

Source: own study based on the interview survey, N = 136.

Transformational leadership (Arnold et al., 2007) or coaching leadership as the people managing theory can be useful at the RHCs, particularly in regard to those who want to grow in the organization, showing such persons that they are able to do more than they thought they could based on their own perception of themselves. Such fact motivates them to a greater effort because they will believe that they can really do more.

The respondents to whom the "need to act" was a strong motivating factor to join the RHC also specified factors such as: "integration with others", "willingness to do something with others", "interaction with people". **Thus hypothesis no. 2, i.e. in rural areas "integration**

with others" and "interaction with people" are the motivating factors to participate in the RHCs is confirmed. The motivating factor "facilitated sale of handicrafts thanks to the RHC" was strongly correlated with "access to fairs thanks to the RHC". To those respondents who listed "integration with others" as one of their motivating factors, "interaction with people", "willingness to do something with others" and "the need to act" were equally important factors.

Other reasons of joining the RHC which were not suggested in the survey were provided by 37% of the respondents (51 persons) and included "willingness to get the society to take action instead of complaining". Sometimes motivation results from a goal being a specific project, for example, one of the respondents wrote that "I wanted to stimulate the place where I live and renovate old buildings which have not been renovated for years". Based on the survey responses one can see that the respondents would like to contribute to positive changes in their villages and improve the life of younger generations, maintain traditions, support the development of children and youth, share their passions, hobbies and local culture which includes the participation of the RHCs in cooking, nature and artistic workshops (e.g. dance). The respondents emphasized that without the RHCs "nothing was going on" in their villages. Thanks to the fact that the members of the RHCs are motivated to perform social work, local human capital is mobilized, integrated and new elements are not only maintained but also introduced into local culture ("at least since we have the RHC something has been going on in the village", "Creating new ideas for workshops, experimenting with new flavors/dishes"). Sometimes the RHCs stimulate the inhabitants of neighborly villages to become active - "there are RHCs in other villages so we can have one, too!". Other motivating factors to become involved in the activities of the RHC included "promoting one's region and culture", "taking care of one's small homeland, supporting initiatives and the development of one's village". Promotion should be particularly important as a motivating factor behind collaboration in the case of those villages that are interested in developing agritourism and rural tourism. The respondents also expressed their motivation to be members of the RHCs in the following way: "I like being with people, I would like to help them, it gives me great joy and satisfaction", "I like it, social activism is in my DNA", "I love working with people and for people". One of the respondents directly wrote that: "there are no leaders whereas the demand for volunteering in my area is high". Many respondents emphasized motivating power of the purpose of their activities, e.g. "integration, mobilization of our community".

"Willingness to help others" was a motivating factor more frequently specified by unmarried vis-a-vis married people (Figure 3). **The above confirms hypothesis no. 3.**

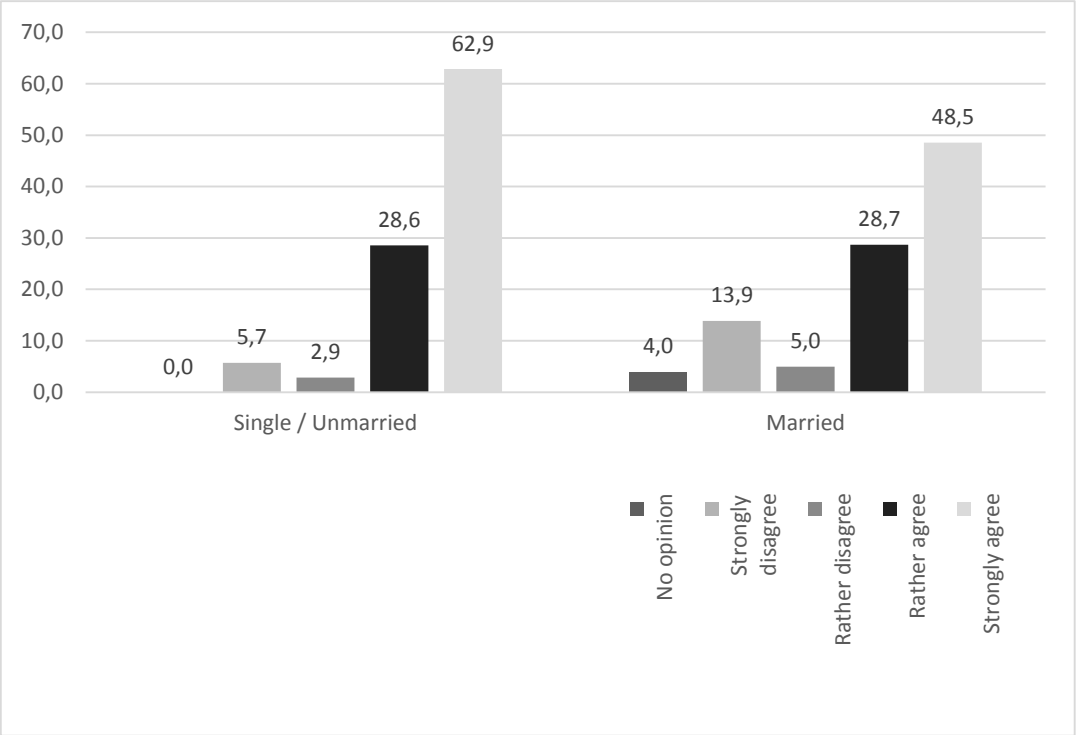

Figure 3. The "willingness to help others" motivating factor by marital status (%).

Source: own study based on the interview survey.

"The need to go out" as a motivating factor to become involved in the RHC is characteristic of the age group 61-70 (Figure 4 – negative values refer to the responses "I definitely disagree " and "I rather disagree" for better visualization of the structure of the responses), where 87.5% of the respondents specified that factor (a sum total of the answers "I rather agree" and "I definitely agree"). As an organization the RHC plays an important role in the rural areas where Catholic Church is frequently the only organization close by. The above is particularly true in the case of seniors to whom mobility can be an issue. "The need to go out" was more frequently specified as a motivating factor by people aged 18-30 compared to the 31- 40 age group. **Therefore, hypothesis no. 4 is deemed false.**

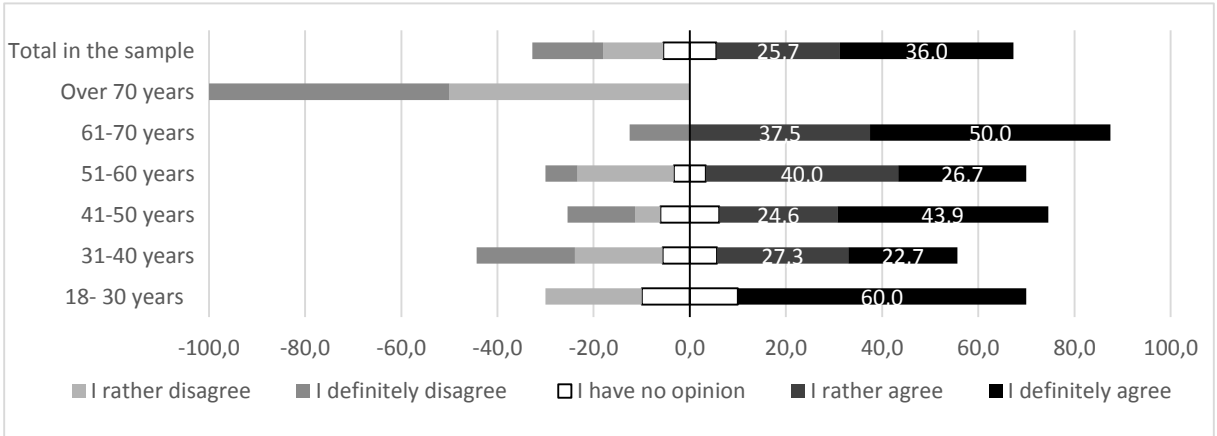

Figure 4. "The need to go out – an escape from everyday problems and duties" motivating factor by the age of the respondents (%).

Source: own study based on the interview survey.

3.2. The activity of Rural Homemakers' Clubs and subsidiarity of those organizations to the respondents

The RHCs are useful to the respondents mostly when it comes to social interactions (85.3% of the respondents). The above is strongly linked to the following two motivating factors: "the need to go out – an escape from daily problems and duties" and "performing a public function facilitates negotiations with local authorities".

The RHCs are helpful with social advancement to a much smaller group of the respondents (46.3%). Those respondents who indicated the relation between being a member of the RHC and their social advancement frequently specified that they were motivated to join the RHC because "performing a public function facilitates negotiations with the representatives of local authorities" and they were motivated because of "access to fairs thanks to the RHCs". To those who find the RHCs helpful in their professional work, "facilitated sale of handicrafts thanks to the RHC" and "access to fairs thanks to the RHC" were the motivating factors. It seems that in the case of the entrepreneurial RHC members their membership allows them to more easily promote their merchandise and reduces financial barriers to market entry. As a result the above is helpful both in their professional work and social advancement. **However, hypothesis no. 5, namely, the RHC membership is most helpful when it comes to social advancement, is not true.**

Table 2.
The structure of survey responses to the question "In what areas is the Rural Homemakers' Club helpful to you?"

The RHCs is helpful with:	No.	%
social interactions	116	85.3.
social advancement	63	46.3.
professional work	36	26.5.
domestic responsibilities	35	25.7.
Other responses	30	22.1.

Source: own study based on the interview survey, N = 136.

Other areas in which the RHCs are helpful to their members which were not listed in the survey and were added by the respondents included education (5 respondents) which mostly involved sharing culinary experiences and opportunities related to taking part in training sessions through the RHCs. Two respondents stressed that their membership helps them overcome their own barriers and weaknesses. However, the respondents did not specify exactly if overcoming weaknesses involved an element related to culinary, social or other education. Approximately five of 126 respondents believe that the RHCs play an important role when it comes to networking. It is a particularly important aspect to migrants in the process of adapting to a local community. One of such respondents wrote that they like observing and analyzing the behavior of the RHC's members in different situations and drawing their own conclusions. To another respondent the RHC helps improve relations between the city and the village. Two respondents specified that their membership in the RHC is the source of social recognition and prestige. Based on the respondents' answers, the RHCs are also helpful in the process of

obtaining external funds for the inhabitants of small towns and villages, facilitating the promotion of products and organizing trips or events.

All surveyed Rural Homemakers' Clubs organized various events (table 3). The smallest percentage of the respondents indicated the RHCs' activities in the area of childcare services, e.g. during holidays.

Table 3.
Activities of the surveyed RHCs

Type of the RHC activity	No.	%
Organizing various events	126	100.0
Participating in harvest festivals	121	96.0
Traditional culinary activities	120	95.2
Folk crafts, e.g. making harvest wreaths	107	84.9
Obtaining funds from external sources, e.g. as part of assistance programs for agriculture	91	72.2
Organizing training courses for local communities, e.g. cooking	79	62.7
Organizing trips for inhabitants	75	59.5
Lending household equipment, e.g. a food processor	58	46.0
Promoting good examples of female entrepreneurship in rural areas, e.g. new sources of income	55	43.7
Enhancing the village's appearance by organizing contests, e.g. for the most beautiful garden	46	36.5
Organizing meetings with the youth, e.g. discussions with interesting people	45	35.7
Organizing trips for inhabitants	45	35.7
Organizing fitness classes	40	31.7
Organizing folk bands	13	10.3
Providing childcare services (e.g. during holidays)	10	7.9
Other activities	21	16.7

Source: own study based on the interview survey, N = 136.

Other activities of the RHCs specified by the respondents included:

- educational classes, workshops for the youth, adults, other RHCs e.g. "Zielnik Pomlewski" (herbarium collection), "Późne grzybobranie" (late mushroom hunting), "Pszczoły nasi przyjaciele" (bees - our friends) (4 responses),
- supporting seniors, performing activities in the area of preventing addictions and counteracting domestic violence,
- fostering a more health-conscious attitude among the women from rural areas,
- collaboration with the Gmina Culture Center and territorial self-government authorities by spreading information about cultural events, e.g. among children,
- promoting the village by taking part in markets/supra-local fests, foreign trips aimed to promote the region and combined with meetings with the Polish diaspora,
- promoting environment-friendly attitudes among the inhabitants,
- collecting old photographs related to the village's history and inhabitants for the purpose of writing a book to preserve such historic heritage,
- collaborating with other NGOs, e.g. voluntary fire brigades (OSP) and co-organizing bike rallies, photo competitions, helping with charity fund-raisers.

According to the respondents the activities that are the most helpful to their villages included supporting rural women's access to education (Figure 5). Moreover, promoting rural women's greater participation in the public life was important to them. Thanks to understanding the expectations of the RHCs' members, the RHC goals can be adapted to fulfill those expectations which will motivate the members to be more active in the organization.

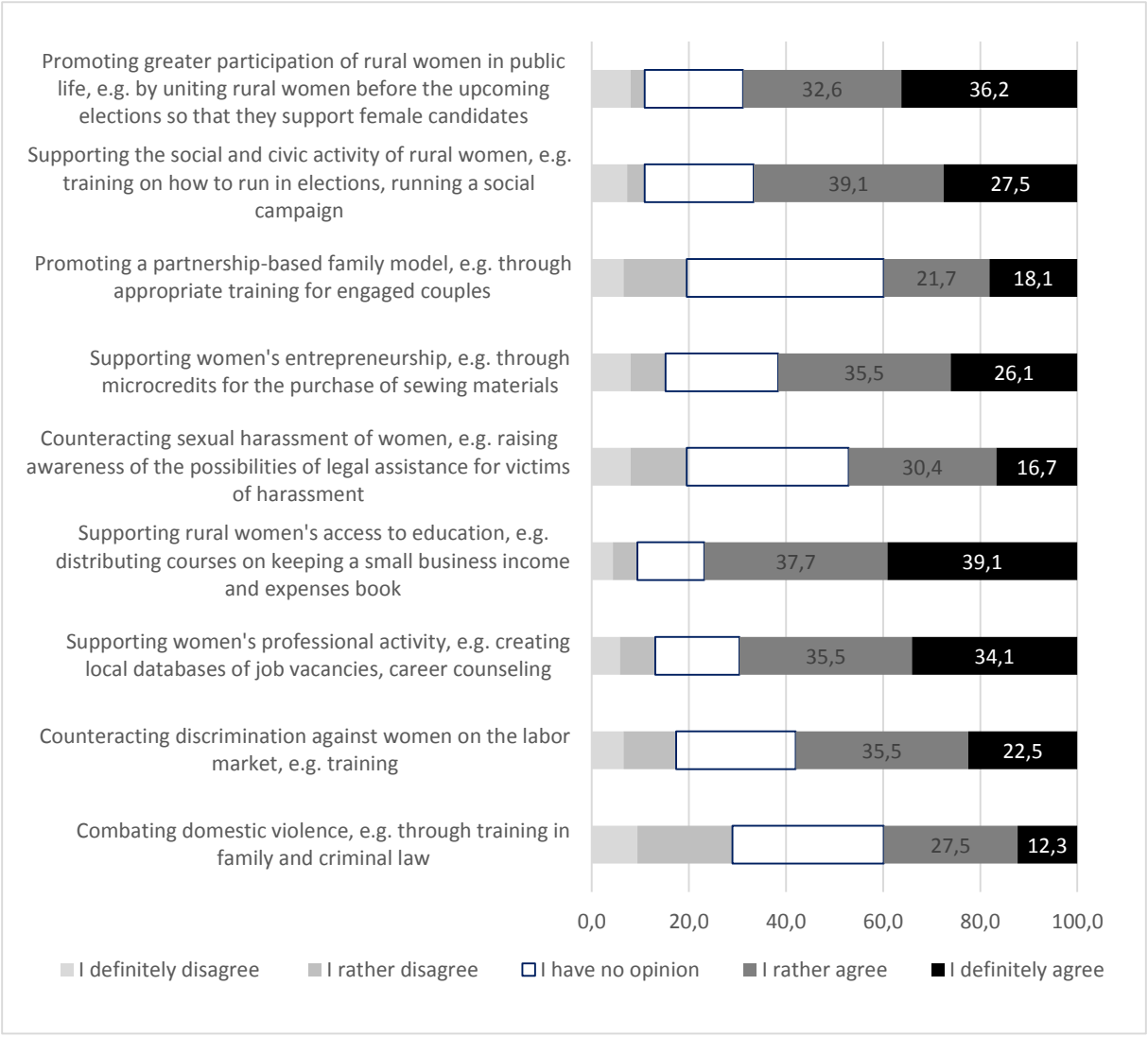

Figure 5. The activities which would be the most helpful in the area where your RHC operates (%). Source: own study based on the interview survey, N = 136.

The important activity which the respondents find to be the most helpful is promoting the participation of women from rural areas in public life and supporting female candidates in elections, e.g. self-government elections. To that end training in participating in the elections would be helpful, too.

3.3. Factors that influence women's involvement in the activities of NGOs

Women had not been involved in non-governmental organizations until mid-19th century due to the fact that state education was only designed for men. There were private "boarding

schools" but girls did not belong to the broadly defined "student brethren". Another reason was that women were not accepted as members of male organizations and there were no female organizations back then. The first female ideological and political union was the union of "Enthusiasts" led by Narcyza Żmichowska (Kamiński, 1971) (established in 1846). The third reason of the women's non-participation in the organizations in the 19th century was that they had not been aware of their equality and having social rights equal to those of the men. Since they were unaware, they had no aspirations to establish or join the organizations.

Their youth was a short period which was a factor that also adversely affected their involvement. They were married young and frequently against their will (Lorenc, 2008) which did not contribute to improving living conditions. Frequently children that had been born died from poverty, athrepsia and diseases and many women had died in labor.

During the partitions their involvement was affected by the fact that women defended men arrested by the occupants for their participation in manifestations, e.g. against serfdom. The occupants found women to be so obstructive that Otto von Bismarck recognized the Polish woman as a dangerous foe to his expropriation policy. In one of his speeches he said: "(…) had it not been for their women I would have exterminated Poles long time ago" (Syguła, 2009). Thus, no wonder that one of the occupants, Austria, pursuant to the Act on associations banned women from joining political organizations (Lorenc, 2008).

Age and education are the factors that have affected rural women's involvement in organizations. The research conducted in the 1970s shows that women aged 31-45, in particular those aged 36-40, had the highest rate of membership in the organizations in rural areas. Bednarski also noted the influence that education had on the increase of the rate of their membership in the organizations (Bednarski, 1978). To a lesser degree that concerns social and economic organizations which were not characterized by such material differences in the membership of women having different levels of education. Moreover the research conducted in the 1970s clearly shows greater involvement among the women from small- and medium-sized farms of the area between 5 and 15 ha. The women from the smallest farms of the area below 5 ha and from large farms (over 20 ha) were less involved in different kinds of organizations. Bednarski explained that phenomenon with class-related factors. The Communist doctrine connected women's historic past and their future to Marxism. As part of the doctrine women were to take part in the "proletarian" class struggle of men in political parties established by them.

Other factors also had impact on women's involvement in the works of political, social and economic organizations, for example: (Bednarski, 1978):

- the size of the village as measured by the number of families (larger villages are usually more active),
- the environment's cultural traits (cultural and educational infrastructure, traditions of cultural activities, readership, development of radio and TV network),
- location (the proximity of large cities, and consequently the impact of urban civilization and culture on the inhabitant's activities).

Bednarski and Gustowski in their work entitled "Społeczne uwarunkowania zdrowotności kobiet wiejskich" [Social conditions of rural women's health] (Bednarski, Gustowski, 1978) indicated that rural women had no free time. They worked too long and frequently too hard. Rural women did not have enough time to satisfy their physiological needs such as sleep, meals, rest and entertainment. The authors pointed out that women in rural areas often sleep less than physiologically required, i.e. 7 to 8 hours of sleep per night for adults. The absence of free time resulted in the excessive strain of their bodies and also limited the possibility of consulting a physician as needed; it also prevented them from broadening their basic medical knowledge.

Currently the major reason for the non-involvement of some women in the activities of the RHCs is the excessive number of household responsibilities (65% of respondents answered "I rather agree" " and "I definitely agree" – Figure 6 – negative values refer to the answers "I definitely disagree" and "I rather disagree" for better visualization of the structure of the answers). Due to the excessive burden of household responsibilities women do not have time to get involved in social organizations (65%). Lack of confidence is another important reason why women do not get involved (61%). Many husbands are not willing to support women's involvement in such organizations as reflected in a similar percentage of answers (61%). Certainly there are few women who do not get involved in the RHCs because of problems with getting there (11%).

The sixth hypothesis was confirmed and, indeed, in rural areas husbands frequently do not approve of their wives' involvement in the works of the RHCs. Family patriarchalism is still a feature of the Polish countryside and thus many women are limited in their aspirations.

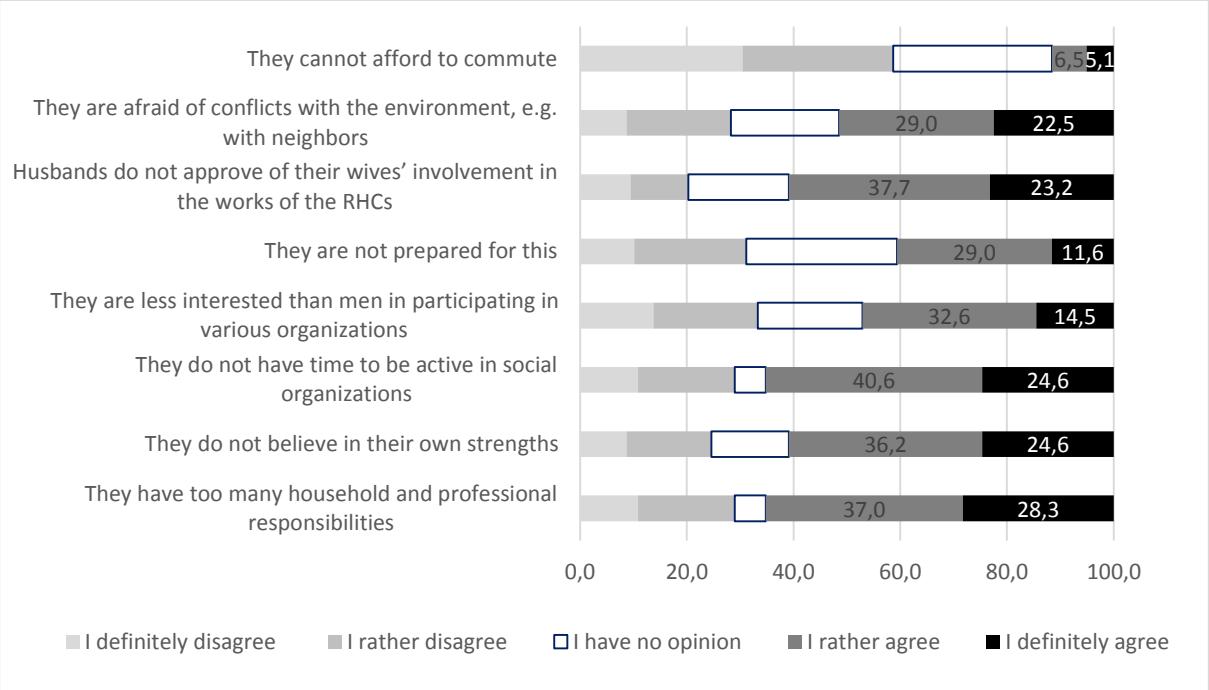

Figure 6. Reasons of some women's non-involvement in the work of the RHCs by respondents (%).
Source: own study based on the interview survey, N = 136.

One of the respondents stated that lack of time is most frequently an excuse as people are not willing to contribute anything “for free". Other reasons of the lack of motivation to join the RHCs include: neighborhood disputes, divisions, political arrangements, internal disputes among the members of the RHCs, hostility, aversion to migrant women, jealousy and stubbornness, e.g. some women are reluctant to meet with current members of the Clubs. Another obstacle is the lack of childcare during their work for the RHC. The respondents also specified their lack of confidence and family conflicts caused by blaming women for spending time “nobody knows how and with whom".

In their research Tryfan, Rosner and Pięcek asked women to provide reasons for their non-involvement in the works of the organizations. The authors identified four major reasons for the women’s non-involvement in NGOs (Tryfan, Rosner, Pięcek, 2003):

1. excessive number of domestic responsibilities,
2. recognizing family matters as a priority,
3. traditional views of the woman’s role,
4. fear of local conflicts.

In another paper Tryfan (1968) argues that the amount of free time is not the most important determinant of the rural women’s social engagement. Her research shows that wives of peasants-workers who bear the greatest burden of family and production responsibilities join the organizations more frequently than the wives of farmers who only practice one profession (Tryfan, 1968.). **Her research shows that the husbands’ profession is an important factor when it comes to the rural women’s involvement in organizations.** Every fourth respondent was unmarried. As regards the married respondents, only 13% of husbands were farmers. Despite work on the farm as declared by 38% of the respondents, it is clear that the connection of the families of the RHC members to agriculture is quite poor. It can be concluded that mainly the women from families poorly connected to farming, whose husbands practice two professions, are active in the RHCs. Apart from having a farm the husbands are sole traders and most frequently work as drivers, mechanics, teachers, electricians, managers of various units, IT specialists, office workers, warehouse workers, firemen or clerks.

Tryfan (1968) describes an interesting case of a woman who was elected a village head and the effect of her involvement on her husband. The husband believed that such division of functions was a shame and started to avoid working at home and on the farm to force his wife to resign from the position. Another interesting example is a father whose daughter was the Chairman of the Union of the Youth of Rural Areas. Rather than being proud of her, he said that ”the girl should be watching her home instead of wandering from one meeting to another”. Thus, those examples show that patriarchate does not favor the involvement of women in non-governmental organizations. Tryfan (1968) concludes that women from older age groups are the most involved ones. At that time maternal duties effectively hindered women’s involvement in the organizations. The women’s profession and education as well as any and all components of the notion of awareness are factors important to their involvement. The author points to the

relation between the women's readership activity and their social activity. The proximity of cities is a factor that has positive impact on the activities of women in political and economic organizations. However, artistic activities are not affected by that relationship as they are frequent both in peripheral areas and the areas located in the vicinity of towns or cities.

Table 4.
The ranking of reasons of women's non-participation in the organizations

Details	Responses	
	No.	Percentage (%)
Excessive number of domestic and professional responsibilities	157	24.3
They lack self-confidence	113	17.5
They do not have time to get engaged in social organizations	98	15.2
Compared to men they are less interested in such matters	96	14.9
They are not prepared for that	80	12.4
Many husbands do not encourage such involvement, do not approve	51	7.9
They are afraid of local conflicts, e.g. with their neighbors	34	5.3
They cannot afford to get there	17	2.5

Source: Tryfan, Rosner, Pięcek, 2003, p. 100.

3.4. SWOT analysis of the surveyed organizations

Strong relations between the activists and clearly defined activities are the most frequently specified strengths of the Rural Homemakers' Clubs (Figure 7). According to the respondents, "having a choral ensemble" and a "strong relation to the National Union of Agricultural Clubs and Agricultural Organizations" are hardly regarded as strengths. The greatest number of respondents ("I definitely agree") indicated strong leadership.

The respondents also had an opportunity to specify, in their view, the strengths of the RHCs. The responses quite varied. One the respondents was of the opinion that close collaboration with a local elementary school was a strength enabling the RHC to educate children in ecology and production of organic foods. To another person co-operation with seniors and NGOs were strengths.

Some RHCs recognize manual skills of its members and maintaining traditions as their strengths. Apart from handicraft skills another strength is acquiring new skills and knowledge from others (lifelong learning). Having own cabaret and willingness to enter contests are also regarded as the strengths of some of the RHCs. Engaging in promoting their villages is yet another RHC's strong side. Frequently the RHC is the only form of women's organization in the country allowing to foster personal contacts between the inhabitants, often in a family atmosphere.

One of the respondents mentioned the RHC's experience in obtaining subsidies as a strength, as the Club continues the work of an association of a different kind. By definition, the Rural Homemakers' Club is a group of people who want to work together to develop their village, foster human relations. It involves local co-operation. One of the respondents specified "youth and commitment" as an opportunity for the RHC.

Other strengths included:

- age diversity,
- women who have strong character,
- cooking and original ideas for the Club's overall activities,
- mutual friendships,
- openness to the needs of individuals in crisis, e.g. refugees,
- social activities benefitting the inhabitants,
- creating handicraft and participating in contests,
- willingness to act,
- promoting the village in the poviat and voivodeship,
- the ratio of active to inactive RHC members.

Networking and co-operation with other organizations is a strength of approx. 68% of the surveyed RHCs (Figure 7). In the case of seven out of ten RHCs, their members' work enthusiasm (approx. 68% of the responses) are also strengths.

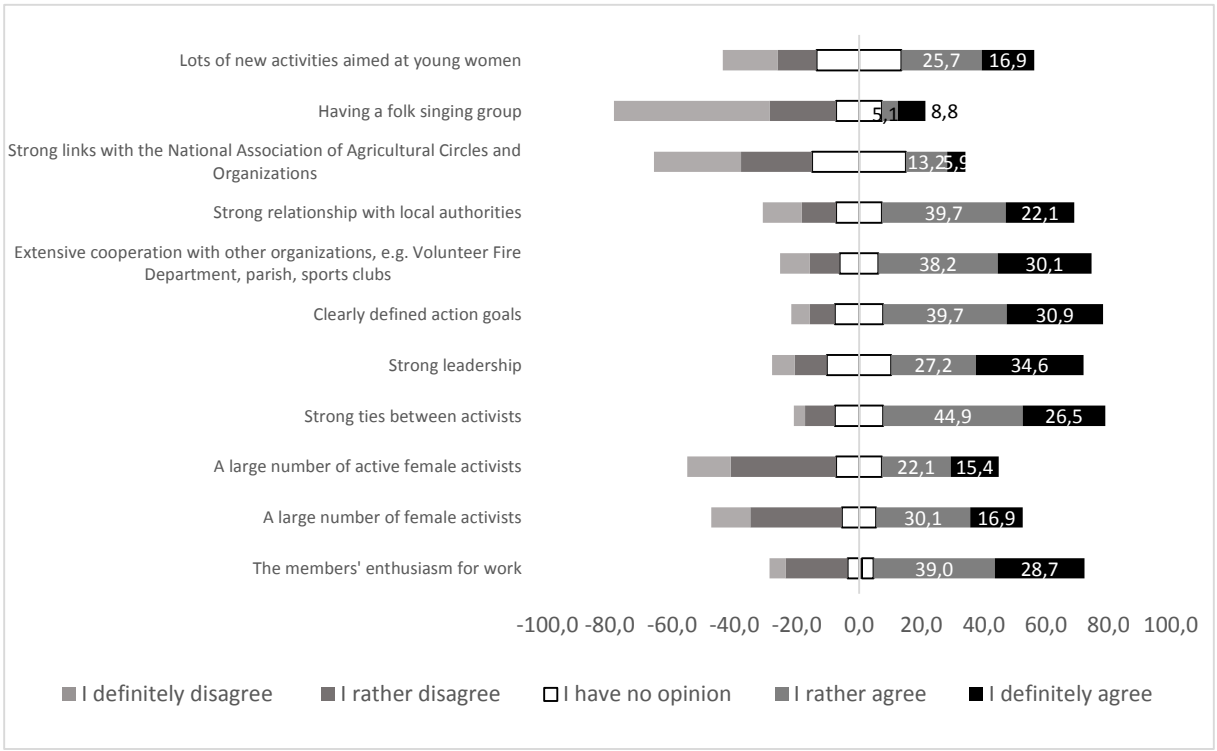

Figure 7. Strengths of the Rural Homemakers' Clubs (%).

Source: own study based on the interview survey.

One of the weaknesses of the RHCs is the lack of interest in the Clubs' new ideas among young women, activists (Figure 8). Weak leadership is the lowest risk. Approximately 50% of the RHCs do not have sufficient funds for the performance of their tasks. Another weakness is the lack of a folk choir ensemble (34% of responses) and a poor relationship with the National Union of Agricultural Clubs and Organizations (32% of respondents).

Other weaknesses specified by the respondents apart from those presented in Figure 8 included failure to "identify with social good", "mentality", "lack of a serious attitude to the RHC". One of the respondents noted that excluding new members and failure to get the inhabitants involved in the activities of the RHC are also weaknesses. One of the weaknesses of another RHC located in a large village lies in the fact that the majority of the inhabitants work in a city nearby and that the village inhabitants mostly have migrant background and are not interested in their place of residence. One of the respondents noticed that local communities do not quite understand the nature of the RHC with a legal personality. Three surveyed RHCs do not have their seats and there is no such perspective, hence they do not have a place for their organizational meetings. In some villages their inhabitants have misconceptions shared by some of the RHC members that hinder part of the initiatives. Malaise and apathy are weaknesses observed in one of the RHCs in a rural community being a former state-run-farm. In some places the fact that there are too few inhabitants resulting in too few members of the RHC can be an impediment to the organization's operations. In some RHCs the inhabitants do not have the sense of belonging to the community and disputes among neighbors have adverse impact on the functioning of the RHCs.

Several respondents specified finances as weaknesses, for example:

- a low budget,
- inability to plan long-term activities involving funds from external sources.

A portion of responses regarding the Clubs' weaknesses pertained to interpersonal relations in the Club, e.g.:

- arguments between the members, internal conflicts and rumors,
- too few active members, lack of interest or drive to work among some members,
- absence of people aged around 35 interested in getting involved,
- being a closed circle of members engaged from the beginning, little interest among the members to welcome new ones, working on the principle that "it will be done" usually with the same persons getting involved in a given activity - imprecision, lack of clearly defined tasks,
- dominance of young women with different goals,
- lack of interest among some of the members.

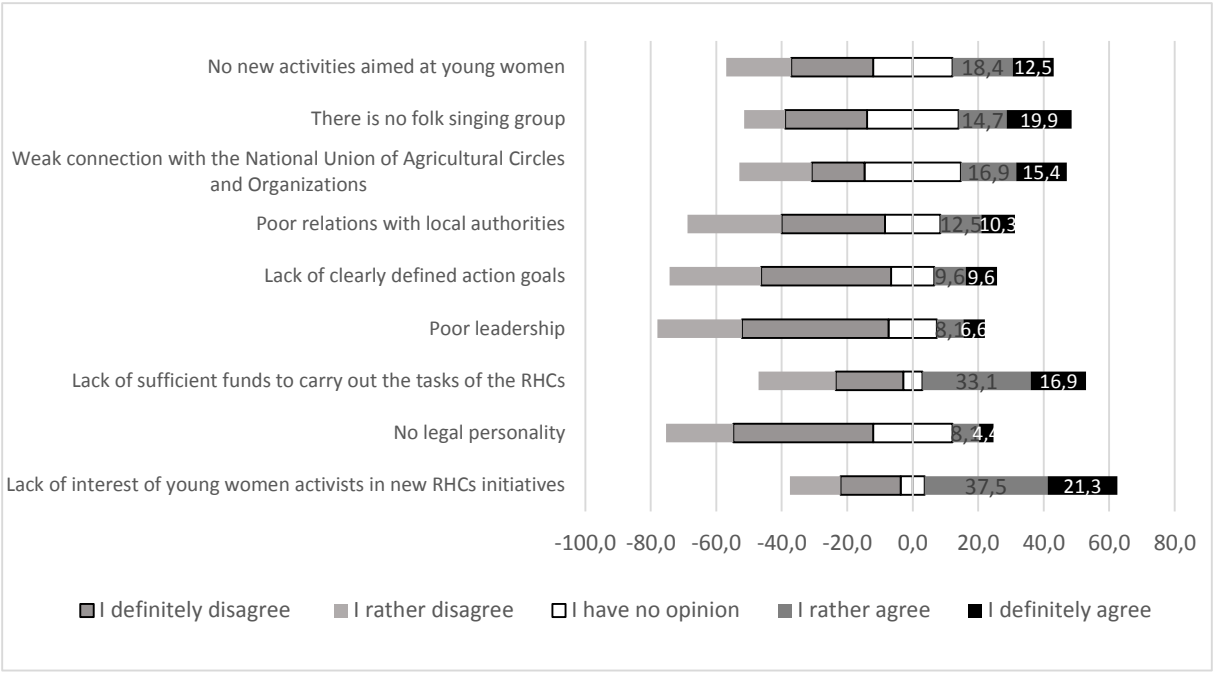

Figure 8. Weaknesses of the surveyed RHCs in the opinion of their members (%).

Source: own study based on the interview survey, N = 136.

According to the respondents a major threat to the functioning of the RHCs is the declining importance of the "real world" among the youth (approx. 60% of the respondents) and the young women's lack of interest in joining the RHC (Figure 9). Approximately 55% of the respondents specified that the inhabitants' lack of interest in the activities of the RHC was a threat. Interestingly, 43% of the respondents believed that the growing importance of the Internet in social life is a threat to the RHC. Only approx. 40% of the respondents regarded difficulty with obtaining funds for the operations of the RHC as a threat. The perception of the Rural Homemakers' Club as an agricultural organization was identified as a threat in the case of four out of ten organizations.

According to some of the respondents one of the threats is the perception of the RHCs as fossilized and uninteresting. Perhaps a country-wide campaign showing their attractiveness could help present their modern face. Treating the RHCs as a place of meetings of elderly ladies (misperception, stereotyping) does not foster their growth and is a threat to the RHCs as organizations.

Another threat is the presence of people who do nothing but criticize. People who try to play off the RHC members or the Club against other organizations without noticing opportunities for the entire community are regarded as a threat. Lack of openness of the society, an omnipresent demanding attitude to other people are threats to the RHC, too.

Other threats to the RHCs as organizations that the respondents specified included:

- a growing demanding attitude and individualism,
- lack of the need to build relationships,
- lack of co-operation with and support from the authorities,
- lack of legal or accounting assistance from, e.g. the Gmina office,

- a declining social activity,
- competition (other RHCs, an association, a foundation),
- rumors, slander, disrespect of the involved members,
- inability to obtain funds for the RHCs without legal personality,
- frequent conflicts with a village head,
- too many formalities in the process of obtaining funds,
- lack of support from gmina offices in the registration process, the organizations' politicization,
- lack of supporting people,
- aggression on the part of the authorities and intimidating the inhabitants,
- the society closing itself off to other people and a negative attitude to anything going on around,
- lack of funds to implement attractive activities that can be of interest to children and youth.

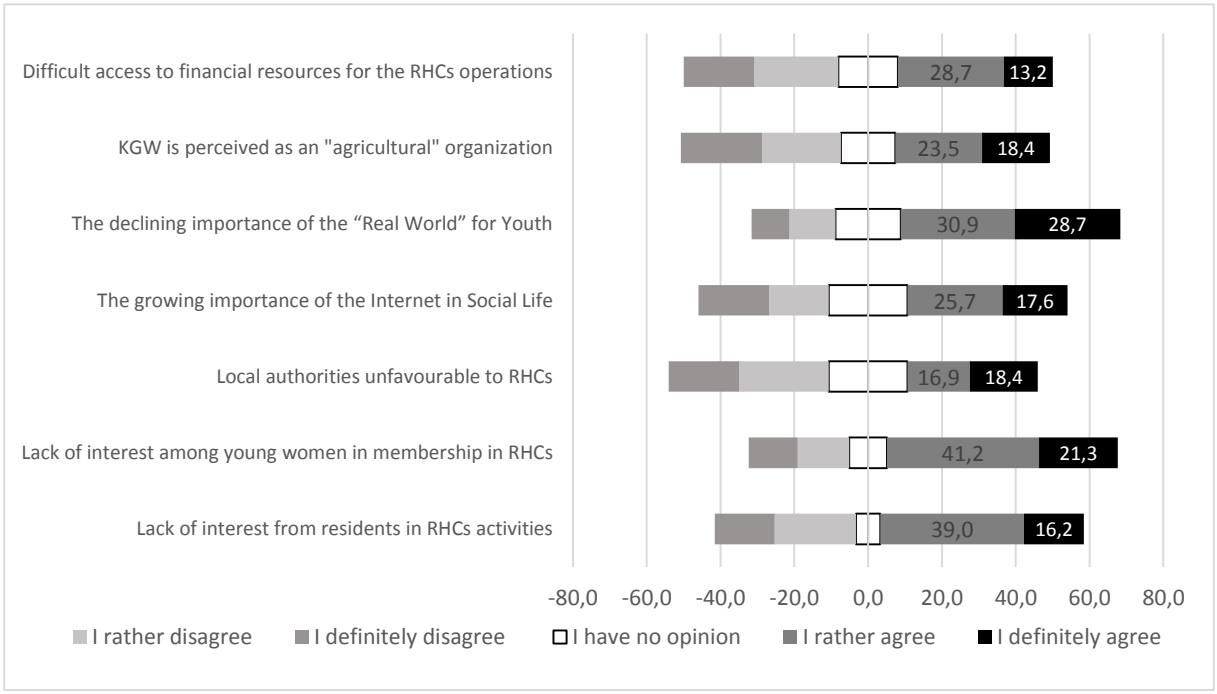

Figure 9. Threats to the RHCs in the opinion of respondents (%).

Source: own study based on the interview survey, N = 136.

A positive attitude of the local authorities (Figure 10) and numerous sources of financing the activities of the RHCs are perceived as opportunities by the members of the RHCs. The declining importance of the "real world" to the youth who mostly spend their time online is hardly recognized as an opportunity.

To some RHCs co-operation with a local elementary school, the possibility of the implementation of shared educational programs in the area of maintaining cultural heritage (financed with EU funds) is an opportunity. Access to sale via the Internet gives the RHCs new opportunities related to sale of folk handicraft. Growing interest in the RHCs as an organization

and their financial support by the State or self-government are obvious opportunities for the RHCs.

Other opportunities specified by the RHCs include:

- a natural setting,
- potential of local environment,
- co-operation with other organizations,
- joining forces and partnerships with neighboring RHCs – integration,
- taking part in charitable works,
- involvement in the RHCs being en vogue as a trend created by the government of the Republic of Poland,
- activities aimed at the integration of senior inhabitants,
- strengthening social relations.

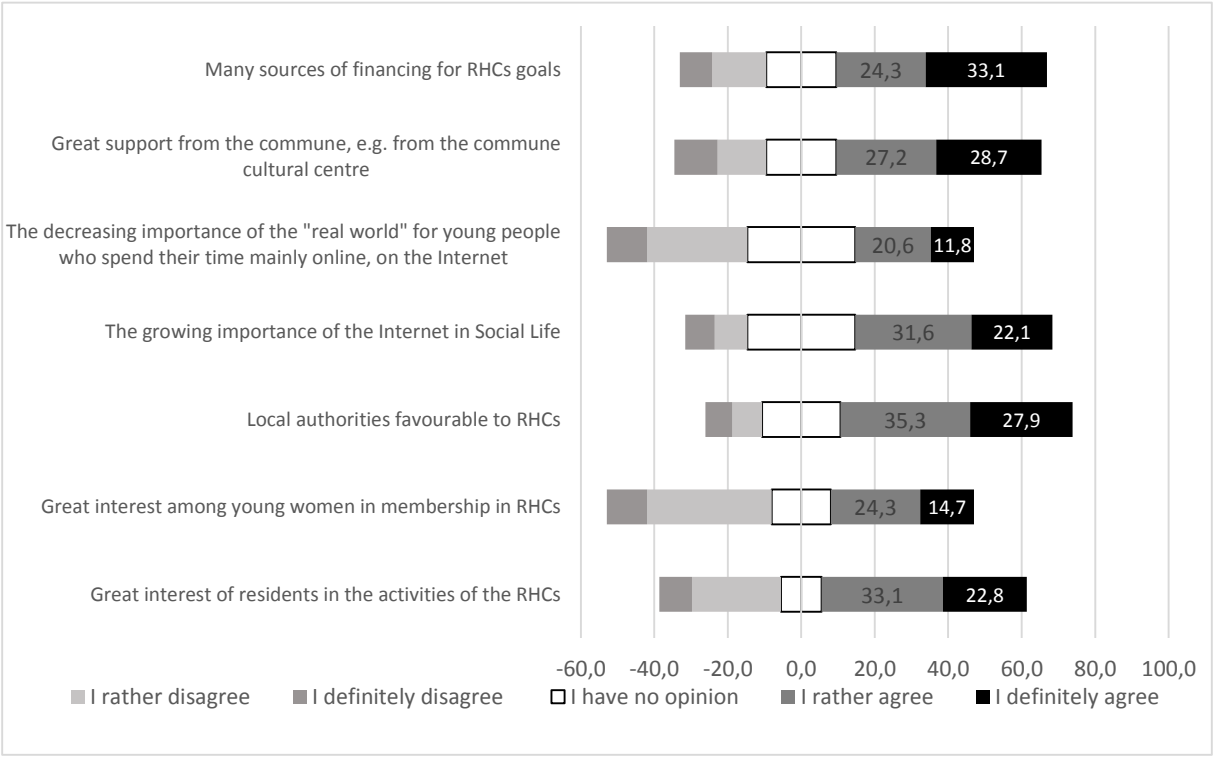

Figure 10. Opportunities for the RHCs in the opinion of their members (%).

Source: own study based on the interview survey, N = 136.

4. Summary and discussion

The respondents mostly included people aged below 50 who are married and have tertiary education. The majority of the surveyed women were hardly involved in agricultural production and farming. Typically the surveyed women were engaged in non-agricultural work.

The Rural Homemakers' Clubs preserve rural cultural heritage for future generations. Every second surveyed Club is engaged in gainful operations as an organization. Almost every second organization engages in networking which mostly involves its co-operation with voluntary fire brigades, self-government and other associations.

In the 1990s women worked longer on farms than now. A major factor motivating the respondents to become involved in the activities of the RHC is personal development and willingness to help others. Thanks to such involvement women have higher self-esteem and are able to adjust to a group being important to the community. Integration with other people and willingness to do something with others are goals of rural women who are active members of the Clubs. To some entrepreneurial women the improvement of the relation with the market thanks to the RHC is an important factor motivating them to take part in the activities of the RHCs. To seniors the RHCs are an incentive to go out. Therefore the Rural Homemakers' Club helps with social interactions.

The Rural Homemakers' Clubs engage in interesting local initiatives and influence local communities organizing local events and implementing a number of unique initiatives. Those initiatives are related to education, promotion of local tourist attractions, maintaining local tradition.

Factors that affect women's activities in NGOs such as RHCs have changed over time. During the period of the partitions of Poland, non-governmental organizations allowed women to help their husbands arrested by the occupants. After the World War II women from small farms as well as from the very big ones were more active. At present women in rural areas have fewer responsibilities related to agriculture. However, it does not mean that they have more time which can be devoted to being involved in NGOs. The husbands continue to be the factor discouraging women to become involved in the RHCs.

The hypotheses that were validated:

- leadership in the RHCs should take the form of coaching leadership because personal development was the major motivating factor of the women's involvement in those organizations.
- In rural areas the factors that push women to participate in the RHCs were "the need to act", "integration with others" and "interactions with people".
- Willingness to help others is a factor characteristic of unmarried rather than married people.
- The most important disincentive for people to get involved in the activities of the RHCs is failure to accept such activities by life partners.

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IDENTIFICATION OF THE CAUSES OF PRODUCTION EQUIPMENT FAILURE USING MACHINE LEARNING METHODS – A CASE STUDY

Izabela ROJEK[1], Małgorzata JASIULEWICZ-KACZMAREK[2*], Mariusz PIECHOWSKI[3], Dariusz MIKOŁAJEWSKI[4]

[1] Faculty of Computer Science, Kazimierz Wielki University, Bydgoszcz; izabela.rojek@ukw.edu.pl, ORCID: 0000-0002-9958-6579
[2] Faculty of Engineering Management, Poznan University of Technology in Poznan; malgorzata.jasiulewicz-kaczmarek@put.poznan.pl, ORCID: 0000-0002-8332-3192
[3] Faculty of Engineering Management, WSB Merito Univeristy of Poznań; mariusz.piechowski@wsb.poznan.pl, ORCID: 0000-0002-8518-5336
[4] Faculty of Computer Science, Kazimierz Wielki University, Bydgoszcz; dariusz.mikolajewski@ukw.edu.pl, ORCID: 0000-0003-4157-2796
* Correspondence author

Purpose: This paper aims to present the possibility of using decision tree (DT) to increase the efficiency and effectiveness of maintenance activities by identifying the probable cause of failure based on historical data.
Design/methodology/approach: This study used classifiers based on General Chi-square Automatic Interaction Detector (CHAID) and random forests. Using this group of classifiers brings with it faster u performance, the possibility to process symbolic data directly, and the possibility to add a tree as part of interactive tree building. A separate tree was built for each input parameter to aggregate the results from both trees by considering them together. The proposed solution also analyzes the importance of features (input data).
Findings: Based on the research conducted, we have shown that using ML techniques can improve the accuracy of decisions regarding the type of maintenance work that should be carried out to efficiently and effectively remove failures and reduce losses caused by machine downtime.
Research limitations/implications: The research is worth extending to use other novel artificial intelligence methods to compare the developed models. A limitation was the amount of data. As new data becomes available, the developed models should be trained to respond to the new data and better adapt to it.
Practical implications: Relatively simple AI-based solutions such as CHAID and random forests have yielded fairly high accuracy with very short execution times. Within edge processing, this fulfills the complex trade-off between accuracy and speed in predictive maintenance applications. The presented families of simple algorithms should be developed as a transparent source of opinion for industrial decision-making processes.
Originality/value: What is new is the automation of maintenance activities by identifying the probable cause of failure using AI methods. The solution is aimed at company employees who diagnose the causes of failure, ultimately improving the accuracy and speed of diagnostics and service response.

Keywords: data-driven maintenance, decision-making, machine learning, CHAID decision tree, random forests.
Category of the paper: Case study.

1. Introduction

Maintenance management involves organizing resources to deal with the problems of maintaining production equipment and obtaining maximum benefits from the decisions made. Maintenance decision-making includes but is not limited to selecting maintenance strategies, setting maintenance priorities, scheduling work orders, etc. Computerized maintenance management systems (CMMS) are commonly used to support maintenance management processes. These systems enable integrating related data on equipment, work performed and costs, spare parts suppliers, and inventory to manage maintenance workflows, including proactive maintenance planning, reactive maintenance ordering, order fulfillment tracking, and maintenance performance benchmarking.

However, few CMMS systems on the market provide decision-making capabilities, so maintenance personnel must make decisions based on their experience, the information in the operator's system event report and/or maintenance manual, or a combination thereof. This empirical approach to decision-making usually does not produce the expected results. Poor decisions can result in unnecessary or inappropriate maintenance, inefficient use of human resources and time, and unnecessary spare parts purchases.

The operational data collected in CMMS systems is significant and large enough to be used to make decisions regarding the scope and frequency of preventive maintenance. However, if a decision is made about reactive actions (i.e., actions taken after a failure), appropriate analysis of historical data in connection with the information contained in the failure report in the CMMS system will enable better resource allocation and shorten the service implementation time. Historical data contains information about emergency events that occurred on the production line, their causes, and actions taken. With this data, it is possible to automate decision-making processes based on a data-driven approach.

Data-driven approaches, particularly machine learning (ML), are attracting attention (Bousdekis et al., 2021; Justus et al., 2024). The concept of ML is not new, but it still enjoys great interest. Thanks to advances in algorithms, computing power, inexpensive memory, and large amounts of data, recent years have seen a significant increase in the applicability of ML in various areas of engineering practice, such as maintenance processes (Çınar et al., 2020; Cline et al., 2017; Arena et al., 2022; Nguyen et al., 2022; Antosz et al., 2023; Vanderschueren et al., 2023). According to Quatrini et al. (2020), "by using ML tools it is possible to discover the relationship between different factors and analyze the degree of influence of related

variables". ML-based approaches can be applied to high-dimensional and unstructured data and extract hidden relationships within data in the manufacturing environment.

Decision tree (DT) and random forest (RF) models are important ML tools for decision analysis due to their visualization and interpretability features (Kaparthi, Bumblauskas, 2020; Amruthnath Gupta, 2019; Misaii et al., 2022). The article aims to present the possibility of using DT and RF to increase the efficiency and effectiveness of maintenance activities by identifying the probable cause of a failure based on historical data stored in the enterprise's CMMS system.

The paper is structured as follows: Section 2 provides literature reviews. Section 3 explains the methods and materials used in the study. Section 4 presents the study's results. Finally, Section 5 presents the conclusions of this research.

2. Background

Maintenance is defined as "a set of all technical, organizational, and managerial activities during the life cycle of an object, the purpose of which is to maintain or renew the state in which it can be used to fulfill the required function" (EN 13306: 2017). Maintenance plays an important role in every manufacturing company, and its costs, depending on the industry, may constitute a significant percentage of the company's production costs (Rebaiaia, Ait-Kadi, 2023).

Effective and efficient implementation of maintenance processes allows you to achieve numerous benefits, including reduced operating costs, stable level of product quality, reduced environmental impact (e.g., energy consumption, consumables), and more efficient use of resources (Hallioui et al., 2023). Maintenance management professionals implement various maintenance strategies to avoid unexpected production downtime and increase the efficiency of production assets (Mahmud et al., 2024; Gatta et al., 2024). Broadly speaking, maintenance strategies can be divided into three main categories: corrective, preventive, and predictive maintenance. In reactive strategy, maintenance actions are taken when anomalies or failures occur. This approach leads to high costs of unexpected production downtime. Additionally, emergency repairs often require expedited parts shipping, overtime costs, and higher service fees from third-party vendors, further increasing overall expenses. Preventive maintenance (PM) is "carried out intended to assess and/or to mitigate degradation and reduce the probability of failure of an item" (EN 13306:2017). PM can be considered the most common maintenance policy in which a system is maintained preventively at set intervals regardless of the system's failure history. Despite the various benefits that PM can bring, there are many shortcomings, which result mainly from the fact that maintenance activities are generally carried out prematurely, resulting in reduced availability and increased costs (Polenghi et al., 2023).

As modern production systems become increasingly complex and involve highly interconnected machines, traditional maintenance strategies (reactive and preventive) are insufficient. The answer to these challenges is a predictive maintenance strategy supported by the development of digital technologies (Pinciroli et al., 2023; Sanchez-Londono et al., 2023; Wanget al., 2023). Maintenance is an area that can benefit the most from digitalization (Shaheen, Németh, 2022; Saihi et al., 2023) because acquiring and processing data from both machines and the environment in which the production process is carried out can significantly improve maintenance decision-making processes. Regardless of the maintenance strategies adopted in the company, historical data on emergency events, maintenance activities undertaken and their effectiveness are very important. In the case of reactive maintenance, the response time is important, i.e. the time from reporting the incident by the operator to taking corrective actions. The length of this time depends on the quality of the information contained in the notification, as it allows for the identification of the job, the estimation of the required labor force, the identification of spare parts, and the determination of whether and what tools are needed. Analysis of the data contained in the CMMS system allows you to make the right decision and shorten both the response time and the service implementation time.

Concerning the preventive strategy, it is important to define the plan and schedule of maintenance interventions (e.g., time intervals and scopes of individual services) so that they are not performed in excessive amounts and scope. Availability of resources must also be ensured. According to Campbell et al. (2015), planning determines what needs to be done, in what order, and with what skills. The degree to which companies can derive value from data processing and draw actionable conclusions can be an important factor in improving production processes, reducing costs and resource consumption, and thus meeting customer demands.

According to (Carvalho et al., 2019; Emmanouilidis, 2023), one of the promising tools in the proactive maintenance approaches is machine learning (ML) methods. Machine learning is defined as “a set of methodologies and algorithms capable of extracting knowledge from data, and continuously improving their capabilities, by learning from experience (i.e., from data accumulating over time)” (Bertolini et al., 2021). According to Ruiz-Sarmiento et al. (2020), ML techniques “are data-driven approaches that find complex and non-linear patterns in data and build models from them that can be used for prediction, detection, classification or regression”. The literature analysis indicates that the use of ML models in maintenance is becoming more and more popular (Dalzochio et al., 2020; Campos et al., 2019; Abidi et al., 2022; Surucu et al., 2023; Arena et al., 2022; Alsina et al., 2018; Alvarez Quiñones et al., 2023; Chakroun et al., 2024). Decision trees and random forest models are important tools in machine learning.

3. Material and methods

3.1. Problem statement

The present study covered a medical device company. To formulate the research problem, it was assumed that the response time (i.e. the time that elapses from the notification of a failure to the start of the repair process of a localized damaged technical object) is a key indicator of the effectiveness of maintenance activities and translates into the economic efficiency of the enterprise (downtime is a loss). For the aforementioned reasons, particular emphasis should be placed on effectively reducing the aforementioned response time. This is important not only for reducing machine downtime itself but consequently also for optimizing the production process as a whole. To minimize the response time, several preventive measures are taken, starting with maintaining an adequate number and level of training of maintenance services, ensuring monitoring and rapid alarming of equipment anomalies and failures that have occurred, to the rapid and accurate identification and classification of the causes of failures, determining the human resources, tools, materials, and spare parts required for their removal. Mistakes or delays in the latter activities (e.g., the location and identification of failure causes) can significantly affect the efficiency of maintenance operations. The consequences can be costly, leading not only to increased machine downtime but also to increased repair and downtime costs. For the aforementioned reasons, solutions that explore, support, and automate this area are scientifically and economically important. Effective methods and tools, including AI-based ones, are constantly being sought to support human service decision-makers with easier, faster, more efficient maintenance activities using prediction and/or classification. For the aforementioned reasons, ML is increasingly used to speed up failure identification and diagnosis processes.

3.2. Data set

The company under study uses a CMMS system and operators enter emergency reports into it. The emergency event thus entered is described in a uniform procedure using line segment, unit, component, and type of failure. In this way, it is possible to identify where the failure occurred. As part of the same procedure, information on the cause of the failure, the extent of the maintenance work carried out (this may be only adjustment, for example), and the resources involved are entered into the CMMS after the failure has been rectified. These are entered post-hoc by the maintenance technicians.

In the study, the computational analyses were based on actual data over 18 months from the company studied. The data comprised 5000 occurring failure reports and the maintenance staff's associated responses (service actions). The following input parameters were assumed:

- line segment,
- unit,
- component,
- type of failure.

It was also assumed that the following output parameters would be used in the system:

- task type,
- type of repair.

This treatment of the data set enabled the design and testing of the computational tools presented next.

3.3. Statistical and Computational Methods

In this study, Statistica 13 software (StatSoft Power Solutions Inc., Tulsa, USA) was used to perform statistical analyses of the data and develop computational models. This software is relatively often used in scientific research, including the analysis and modelling of industrial issues (Ciężak, Kutyłowska, 2023; Musiał et al., 2023).

Various statistical and computational methods and tools have been used to achieve such a goal (Rojek et. al., 2023; Scaife, 2024). This study used classifiers based on General Chi-square Automatic Interaction Detector (CHAID) and random forests. Using this group of classifiers brings with it faster u performance, the possibility to process symbolic data directly, and the possibility to add a tree as part of interactive tree building. A separate tree was built for each input parameter to aggregate the results from both trees by considering them together. The choice of this solution is based on the need to compromise between the large amount of data to be processed, accuracy, and speed. For the aforementioned reasons, preprocessing or edge processing, i.e., the reduction of the entire input data set to a vector of the most relevant features, is increasingly used, saving computational complexity at the expense of classification accuracy. In our solution, we also applied feature (input data) importance analysis (example for task type: Figure 1).

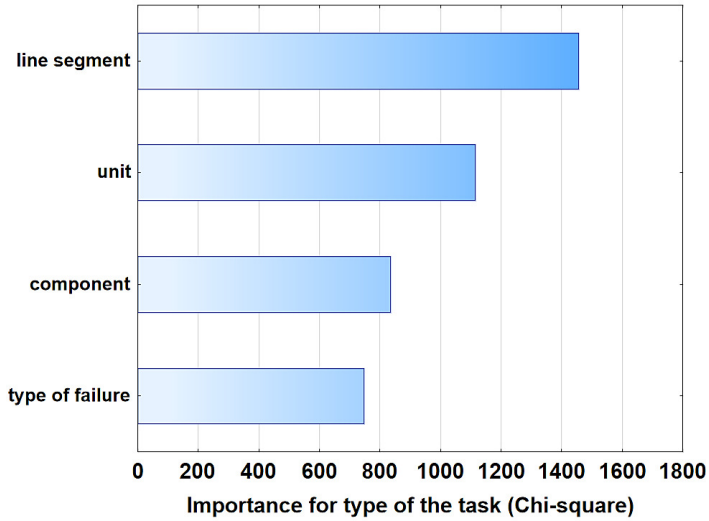

Figure 1. Feature importance for "type of task".

The tree-building algorithm analysis presented below aims to find a set of logical IF partitioning conditions that ensure an unambiguous classification of objects. In this study, we compared the results of two computational methods: CHAID and the random forest algorithm obtained on the studied data set.

CHAID enables the construction of an optimal tree using cross-validation (optional) for classification problems with quantitative and qualitative predictors. The program can determine various statistics of results (predicted classes). For classification, the basis for splitting the node is the chi-square test (p-value with Bonferroni correction). The advantages of this solution include the automatic selection of n-way splits in the node, but the disadvantage is that this approach requires quite large data sets.

The random forest algorithm involves creating and combining many different classification trees. Each tree is created on a random sample of n observations taken with replacement from the training set (bootstrap sample). For classification, random forest is an ensemble ML method that involves constructing many decision trees during training and generating a class - the dominant of the classes of individual trees. In this way, random decision forests improve overfitting to the training set. Random forests provide smoother results with large data sets than traditional decision trees. However, the disadvantage is a certain opacity of decisions: the final decision of the random forest is the average of many independent partial decisions, and it is difficult to simply explain the reasons for making it.

4. Results

4.1. Results for "type of tasks"

In the CHAID tree for "type of task" the number was obtained:

- 5 shared nodes,
- terminal nodes 9 (Figure 2).

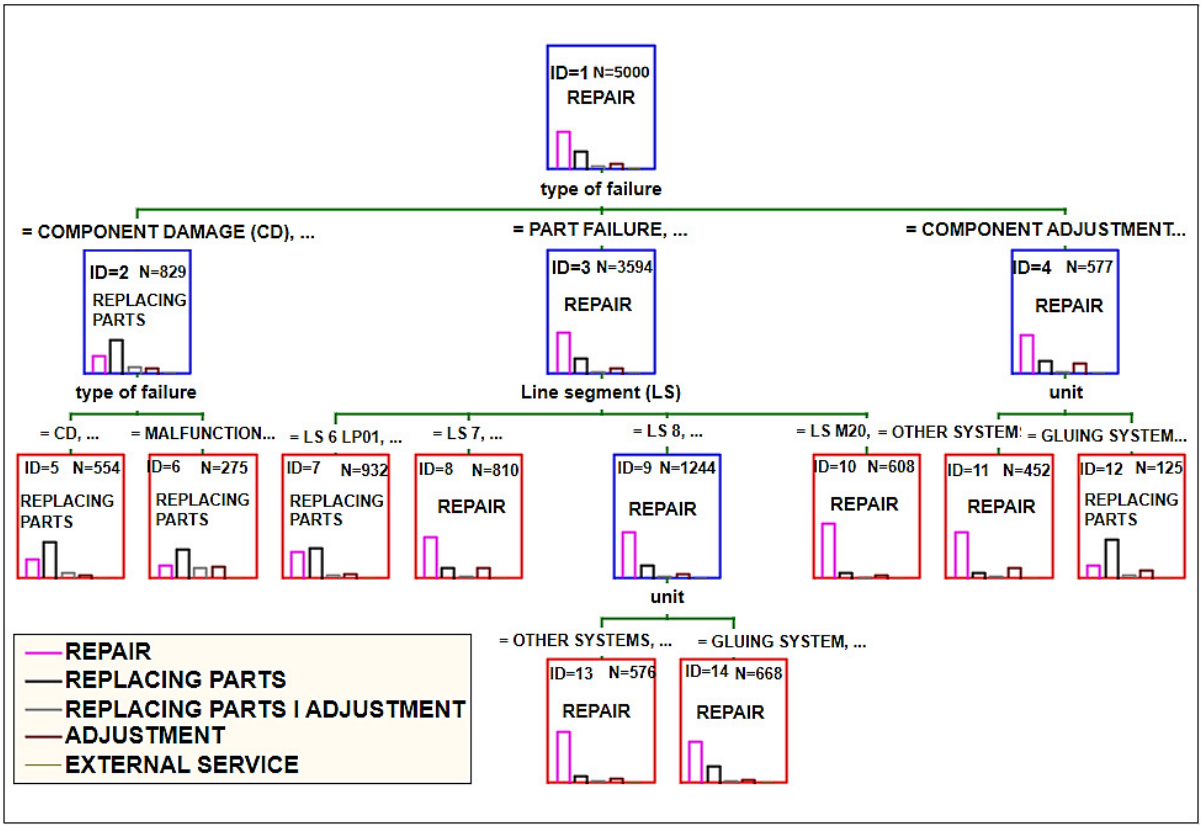

Figure 2. CHAID for "type of task".

Figure 3 shows the classification matrix showing the frequency of predicted and observed.

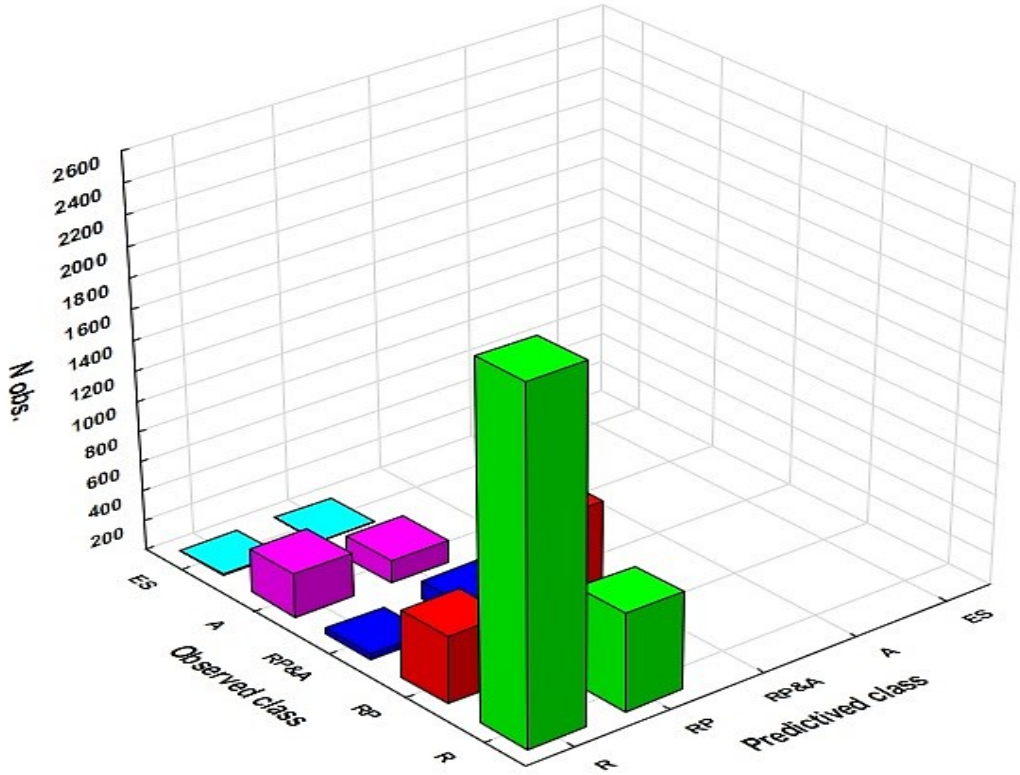

Figure 3. CHAID for "type of task", where: R- repair, RP – replacing parts, RP&A – replacing parts & adjustment, A – adjustment, ES – external service.

For random forests: the number of trees is 100, maximum tree size is 100 (Figure 4).

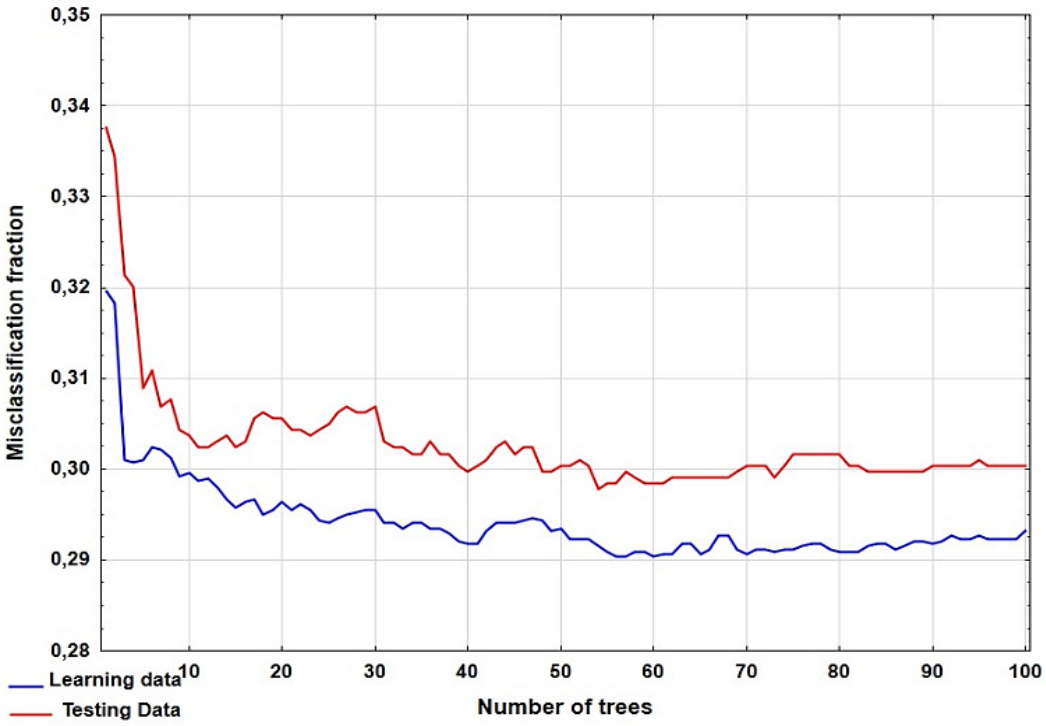

Figure 4. Random forest for "type of task".

Figure 4 shows the basic mechanism to prevent overfitting. In general, as the model is expanded with additional trees, the share of false predictions in the training sample decreases, and after reaching a certain number of trees, stabilization may occur. However, in the test sample, as the number of trees increases, the share of incorrect predictions first decreases and then may begin to increase. The beginning of an increase in error in the test sample signals overfitting of the model and allows us to select the appropriate level of model complexity. In particular, if the error in the test sample stops decreasing as more trees are added, we may consider stopping the training process.

4.2. Results for "type of repair"

Based on the CHAID tree for "type of repair", the number of split nodes was 14, and the number of end nodes was 17.

Based on random forests, 100 trees were built, number of branches: 100. Comparison of the classification matrix between CHAID and random forests showed an advantage of the latter method in terms of predicting all "types of repairs" with lower assessment risk (0.262 vs. 0.356), but a larger error (0.007- 0.011 vs. 0.006).

4.3. Comparison of both approaches

The study realized a comparison of the effectiveness of the two approaches (CHAID, random forests) based on a pre-specified set of criteria: accuracy, risk assessment, and error for tasks and repairs. The comparison showed an advantage of random forests in terms of risk assessment, with an advantage of CHAID in terms of error for tasks and repairs for the classified output values: "task type" and "repair type". The accuracies obtained were similar: 70.75% for "repair type" and 71.46% for "task type", with the inclusion of feature validity resulting in the previously predicted reduction in classification accuracy to 62.53% for "repair type" and 67.31% for "task type", but may speed up action (obtaining a decision) where this is critical.

It should be noted that the final solution is the sum of the classifiers' responses by aggregating the solution for both output values: "task type" and "repair type".

5. Notes in the main text

Modern manufacturing systems are very complex and involve interconnected machines, and an accidental machine failure will not only stop production on a single machine but will also spread throughout the system and cause other machines to be unable to perform their functions at the expected level. Each failure results in downtime and is a loss. If a failure occurs, appropriate action and maintenance must be performed to restore the required machine functions. The downtime depends on how quickly and accurately the cause of the failure is

determined. Based on the research, we have shown that using ML techniques can improve the accuracy of decisions regarding the type of maintenance work that should be carried out to efficiently and effectively remove failures and reduce losses caused by machine downtime.

Relatively simple AI-based solutions such as CHAID and random forests have yielded fairly high accuracy with very short execution times, which, within edge processing, fulfills the complex trade-off between accuracy and speed in predictive maintenance applications. The presented families of simple algorithms should be developed as a transparent source of opinion for industrial decision-making processes.

Due to enterprises' need to effectively use their resources and reduce losses, automating the decision-making process regarding identifying the causes of emergency events and determining maintenance works may be of key importance for improving the efficiency of processes in the enterprise. Although the issue of "failure prediction" dominates the literature, we cannot forget about enterprises in which the use of the predictive maintenance approach is limited due to, among others, machine age and implementation costs. However, it should be noted that failures occur in every enterprise, regardless of the chosen maintenance strategy, and the approach presented in the article can reduce losses.

Current research focuses on eliminating the most important limitations of the described solutions, occurring to varying extents and intensity in both described solutions (CHAID and random forests):

- The impact of data set quality and size, particularly by limiting employees' ability to select classifications to drop-down menu items or numerical values.
- Unbalanced data set in classes, especially in the case of training, when one group of failures occurs more often than others or some components are new and simply do not fail for a long time.
- Risk of overfitting, which can be reduced by using hybrid solutions, including random forests.
- Some approaches require real-time response due to data entry and classification duration.

Further research will focus on:

- Comparison of the effectiveness of various ML methods and techniques that can be used to develop the above-mentioned solutions.
- Standardization of data acquisition, collection, and analysis, both from employees and using IIoT.
- Flexibility, adaptation, and combination of solutions according to needs, including depending on the area of application or the form of data (numerical, descriptive) or their characteristics (e.g., predominance of one type of damage).
- Imaging the results of analyses as part of human-machine interaction.

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DEVELOPMENT TRAJECTORIES AND TECHNICAL EFFICIENCY OF AGRICULTURE IN THE EUROPEAN UNION COUNTRIES (2007-2023) IN THE CONTEXT OF THE IMPACT OF THE COMMON AGRICULTURAL POLICY

Robert RUSIELIK

West Pomeranian University of Technology in Szczecin; robert.rusielik@zut.edu.pl,
ORCID: 0000-0001-9821-4047

Purpose: This study aims to identify agricultural development trajectories across 25 EU member states, determine clusters with homogeneous development patterns, and analyse variations in technical efficiency levels and dynamics within these clusters. Furthermore, it evaluates the impact of Common Agricultural Policy (CAP) instruments and proposes a novel classification system to enhance the effectiveness of agricultural policy interventions.
Design/methodology/approach: The analysis employs a comprehensive set of variables reflecting the agricultural production business model's characteristics. The study utilizes EUROSTAT data spanning 2007-2023. Through systematic data analysis, clusters exhibiting similar development trajectories were identified. Technical efficiency measurements within these clusters were conducted using Data Envelopment Analysis (DEA) methodology.
Findings: The research reveals significant heterogeneity in European agricultural development trajectories, enabling the identification of distinct clusters with similar characteristics. These clusters demonstrate varying levels and evolutionary patterns of technical efficiency.
Practical implications: The empirical findings facilitate the formulation of evidence-based recommendations aimed at enhancing and harmonizing efficiency levels across the European agricultural sector.
Originality/value: This research contributes to the existing literature on EU agricultural efficiency by proposing a novel analytical clustering approach that transcends the traditional dichotomy between 'old' and 'new' EU member states. Additionally, it provides policy recommendations for future CAP developments.
Keywords: agriculture, agricultural efficiency, Data Envelopment Analysis, EU-25, Common Agricultural Policy.
Category of the paper: Research paper.

1. Introduction

Agriculture plays a crucial role in the European Union (EU) economy, not only as a source of food, but also as an important element in sustainable development, environmental protection and the maintenance of biodiversity. The agricultural sector in the EU is diverse, ranging from intensive farms in countries such as France and Germany to smaller, family-run farms in regions such as Central and Eastern Europe. Agriculture is also a key factor in sustaining rural communities, providing employment and supporting local economies. However, as the world grapples with the challenges of sustainability and resource efficiency, it is necessary to study agriculture in this aspect to ensure its long-term viability (Corato, Cancellara, 2019; Santos, Ahmad, 2020).

The European Union's agriculture is undergoing constant transformation, the dynamics of which intensified especially after the EU enlargement in 2004. It was the accession of ten new Member States, including Poland, that fundamentally changed the structure of the European agricultural sector, introducing significant production resources into the community, but also new challenges related to modernisation and farming efficiency. The differences in the level of technical development, agrarian structure and productivity between the countries of the "old" Union (EU-15) and the new members became the subject of intensive action under the Common Agricultural Policy (CAP), aimed at levelling development opportunities and increasing the competitiveness of the entire sector.

The Common Agricultural Policy (CAP) is one of the EU's oldest and most complex policies, aiming to support farmers, stabilise agricultural markets and ensure food security. Since its introduction in 1962, the CAP has undergone numerous reforms to adapt to the changing economic, social and environmental conditions. Key reforms such as Agenda 2000, the 2003 Fischler Reform and the 2013 Reform introduced mechanisms to promote sustainability, innovation and competitiveness in the agricultural sector. In turn, new rules related to the green transition and digitalisation of agriculture were introduced after 2020. To address the emerging challenges, the EU introduced initiatives such as the Green Deal, which aim to transform the Union into a modern, resource-efficient and competitive economy with no net greenhouse gas emissions by 2050 (Malorgio, Marangon, 2021). It also introduced greater flexibility for Member States to adapt policies to local needs.

The CAP plays a key role in shaping the agricultural policy in the EU, and its reforms after 2004 were aimed at adapting to changing market conditions and societal needs. In the context of analysing the efficiency of agriculture in the EU, changes to the payment system and the approach to sustainable rural development and, in particular, the so-called 'green transition' are particularly relevant.

In summary, between 2007 and 2023, the EU agricultural sector has undergone a significant transformation, driven by both CAP reforms and external economic, environmental and technological conditions. This period covers three EU financial perspectives, allowing for a comprehensive assessment of the impact of support instruments on changes in technical efficiency in agriculture.

Previous studies on the technical efficiency of agriculture in the EU have focused mainly on the selected aspects or shorter periods of analysis. There is a lack of comprehensive studies taking into account long-term changes in technical efficiency in the context of the CAP impact, especially in comparative terms between groups of countries selected for similarities in the shape of the changes taking place reflecting agricultural development paths in the years analysed. Most comparative studies usually analyse changes either on a regional basis or compare the 'old' and 'new' EU. After the last major enlargement of the EU, enough time has passed to try to construct a different grouping of countries with similar changes than before. This gap is important especially in light of the growing challenges of food security, climate change and the digital transformation of agriculture and the desirability and design of future agricultural policy. Particularly as modern agriculture in the EU faces many challenges that require modern solutions and adaptation. Climate change, with its consequences in the form of extreme weather events, droughts and floods, poses a serious threat to the sustainability of agricultural production. In addition, increasing consumer demands for food quality and safety, as well as pressure to reduce greenhouse gas emissions, require farmers to implement more sustainable practices. In the context of globalisation, EU agriculture must also compete on international markets, which requires increased efficiency and innovation.

The objective of this study is to analyse the technical efficiency of agriculture in the countries of the European Union from 2007 to 2023, taking into account the impact of the Common Agricultural Policy. The study aims to:

1. Identify trends and patterns of agricultural development across the EU in terms of various factors. Identify countries that have undergone similar development patterns.
2. Find differences in the level and dynamics of change in technical efficiency between the EU countries.
3. Evaluate the impact of CAP instruments on development and technical efficiency in different country groups.
4. Identify the factors determining the variation in technical efficiency over the period under review

The realisation of the above objectives will allow the verification of the hypothesis of a progressive convergence of agricultural efficiency between EU countries, together with the identification of 'new' groups of countries similar in terms of assessing the effectiveness of the CAP as an instrument for the modernisation of European agriculture.

The study aims to provide valuable insights for policy makers, farmers and other stakeholders, supporting them in their decision-making on the future of agriculture in the European Union.

2. Literature review

The technical efficiency of agriculture in the European Union (EU) is a critical area of research, particularly in the context of the Common Agricultural Policy (CAP) and its implications for Member States, including Poland. The CAP has undergone significant reforms since its inception, aiming to increase agricultural productivity, ensure food security and promote sustainable rural development.

This literature review synthesises key findings from various studies to clarify the relationship between CAP subsidies and technical efficiency in EU agriculture and also takes into account the research-applied divisions of European agriculture into different groups due to differences in CAP effects.

Previous research suggests that CAP subsidies play an important role in shaping farm technical efficiency across the EU. For example, Latruffe et al. highlight that while subsidies can increase technical efficiency, their effects are diverse and vary depending on the type of subsidy and the specific agricultural context (Latruffe et al., 2016). This is further supported by the meta-analysis by Minviel and Latruffe, showing that public subsidies can have both positive and negative effects on farm efficiency, depending on their structuring and implementation (Minviel, Latruffe, 2016). This is also reflected in the findings of Galluzzo, who notes that the first pillar of the CAP, which includes direct payments, has played a key role in supporting farm efficiency in the EU Member States. The findings revealed the positive impact of financial subsidies granted to disadvantaged rural areas on increasing technical efficiency and the low impact of decoupled payments paid under the first pillar of the CAP on the Romanian farms studied. He also showed that, although CAP subsidies have generally improved productivity, the benefits are not evenly distributed, with some regions experiencing greater improvements than others (Galluzzo, 2020).

Radlinska (2023) found that EU agriculture showed high technical efficiency (90.24%) between 2004 and 2020, with very small and very large farms being the most efficient. However, the relationship between farm size and efficiency is not straightforward. In turn, regional differences in agricultural efficiency in the context of cohesion policy are pointed out by (Cieślik, Rokicki, 2013; Nazarczuk, 2015). Several studies have also analysed the impact of the CAP on agricultural efficiency in Poland. For example, Wilczyński et al. conducted an empirical study on dairy farms in Poland revealing that technical efficiency is significantly affected by the level of CAP support received (Wilczyński et al., 2020). Similarly,

Smędzik-Ambroży et al. analysed the sustainability of Polish farms after the EU accession, finding that CAP instruments positively influenced the sustainability and efficiency of farms (Smędzik-Ambroży et al., 2018). This is confirmed by later research by Błażejczyk-Majka who emphasises the importance of the CAP in increasing agricultural efficiency and reducing regional differences in the level of this efficiency (Błażejczyk-Majka, 2022). It can also be noted that previous studies have indicated that higher specialisation correlates with better technical efficiency. This was found in a study of the technical efficiency of specialised dairy farms in Poland by Špička and Smutka, who used regional data to assess efficiency levels. This is in line with broader findings across the EU, where specialised farms tend to show higher efficiency compared to mixed farms, especially in older EU regions (Špička, Smutka, 2014). Kocur-Bera, on the other hand, discusses how the EU membership and participation in the CAP has changed land management practices and agricultural property prices in Poland, which has also further affected efficiency scores (Kocur-Bera, 2016).

The dual structure of the CAP – comprising direct payments and rural development measures – has played a key role in shaping agricultural practices and productivity. Direct payments under the first pillar aim to stabilise farmers' incomes, while the second pillar focuses on rural development, which includes investments in technology and innovation that can increase productivity (Constantin et al., 2021). The integration of precision farming tools, discussed by Vecchio et al. is one such innovation that can significantly improve the productivity and sustainability of agriculture in the EU (Vecchio et al., 2020).

In summary, the literature shows a complex interaction between CAP subsidies and technical efficiency in EU agriculture, especially in Poland. While the CAP has generally contributed to farm efficiency, the effects depend on various factors, including the type of subsidies, farm specialisation and regional characteristics. On the one hand, the positive impact of CAP instruments on agricultural efficiency can be observed on the other hand, following A. Szerletics, who conducted a literature analysis on the impact of the CAP on agriculture, most of the literature was critical of the current direct payment system and its effectiveness in achieving income policy (Szerletics, Jambor, 2021). Future research should continue to explore these dynamics to provide policy adjustments that can further enhance agricultural productivity and sustainability across the EU. New insights are also required and the division of countries or regions into new groups at which future agricultural policy will be directed.

3. Methods

Data for the study were obtained from the EUROSTAT database. The data cover the years 2007-2023. In order to ensure consistency, variables were selected for the research that cover the main factors of production in agriculture, i.e. land, capital and labour. The data were

grouped into a set of variables the combination of which reflects the specifics of the business model of agricultural production. The following set of variables was adopted for the analysis: (*Y*1) agricultural production (EUR million), (*X*1) agricultural area (thousand ha), (*X*2) labour (thousand AWU), (*X2_2*) wages and salaries (EUR million), (*X3*) direct costs (EUR million), (*X*4) business overheads and depreciation (EUR million). Agricultural production (*Y1*) includes income from crop production, animal production, services and subsidies. Direct costs (*X3*) include: seeds and seedlings, fertilisers, protection, veterinary and feed. Costs comprising the variable (*X4*) include: energy, materials, building maintenance, agricultural services, depreciation and other indirect costs. In the adopted DEA model, AWUs (variable *X2*) were used as the variable showing labour input.

The basic descriptive statistics for the selected years are presented in Table 1. Due to the large scope, statistics covering 3 years, i.e. 2007, 2015 and 2023, are given in the article.

Table 1.
Basic descriptive statistics for the years 2007, 2015, 2023

Specification	Year	N	Average	Minimum	Maksimum	Deviation std.
Y	2007	25	14133,9	648,5	65289,4	17410,4
X1	2007	25	7302,3	492,4	29385,0	7993,8
X2	2007	25	473,8	32,9	2299,3	621,0
X2_2	2007	25	1431,5	73,5	6738,2	1898,4
X3	2007	25	4738,4	256,5	22366,2	5671,4
X4	2007	25	3340,1	133,3	15003,3	3914,1
X5	2007	25	2135,5	68,0	10988,8	2970,1
Y	2015	25	15968,3	876,3	72902,0	19564,3
X1	2015	25	7141,3	476,9	29115,3	7789,6
X2	2015	25	379,1	20,3	1937,1	471,9
X2_2	2015	25	1618,6	74,1	7700,9	2192,8
X3	2015	25	5631,7	367,3	26192,8	6901,1
X4	2015	25	4064,8	214,7	17774,0	4724,5
X5	2015	25	2440,9	113,0	12026,1	3357,9
Y	2023	24	21313,6	1305,0	92194,4	26376,7
X1	2023	24	6648,7	478,5	28240,8	7544,8
X2	2023	24	316,0	16,5	1427,5	383,7
X2_2	2023	24	2065,2	92,7	9077,0	2652,5
X3	2023	24	7634,5	607,4	32263,2	9089,9
X4	2023	24	5164,5	311,7	23987,7	6229,3
X5	2023	24	3042,9	189,7	13515,8	4116,0

Source: own research based on EUROSTAT data.

In the initial phase of the research, an analysis of the development of the trajectories of the individual variables in each country was carried out. Based on this analysis, attempts were made to observe some patterns of change. As a result of this analysis, a grouping of countries with similar patterns of change was carried out.

As a result of the analysis of basic statistics and after a preliminary calculation of the models, Cyprus, Luxembourg and Malta were excluded from the study as countries whose agricultural activity patterns were too different. As a result, the pattern of variables is not sufficiently consistent and, therefore, not suitable for use in DEA models. A separate group was

extracted from these countries, but was omitted from further technical efficiency studies. Also as a result of this analysis, a decision was made to use a DEA model with variable scale effects (BCC) to measure technical efficiency. This choice was dictated by the significant variation in the scale of agricultural activities between the analysed countries. The model's orientation towards input minimisation was adopted, which corresponds to the European Union's sustainable agricultural development policy, which postulates an increase in the efficiency of the agricultural sector through the implementation of innovation and resource-efficient inputs.

In this study, Data Envelopment Analysis (DEA), which is a multivariate and non-parametric method, was used to measure the technical efficiency of agriculture in the European Union countries. The DEA is widely used in efficiency analyses in the agricultural sector. The method is based on the concept of productivity proposed by G. Debreu (Debreu, 1951) and M.J. Farrell (arrell, 1957]). Farrell introduced the concept of an 'efficiency frontier' or 'production frontier' (best practice frontier), which represents the technological production possibilities available to a given decision-making unit, in this case individual EU countries. Farrell's concept was to evaluate the efficiency of a decision-making unit in relation to other units operating under similar technological conditions. The concept was initially applied to one-dimensional cases, but was developed into a multidimensional analysis by A. Charnes, W.W. Cooper and E. Rhodes (Charnes et al., 1978), who proposed a model assuming fixed effects of scale, known in the literature as the CCR model. In 1984, Banker, Charnes and Cooper extended the CCR model with the introduction of the BCC model, which incorporates variable scale effects for more precise efficiency results (Banker, Charnes, Cooper, 1984).

The efficiency measurement concept used in the CCR and BCC models is based on one of the most popular techniques described, among others, in the work Production Frontiers (Färe et al., 1995). With s effects and m inputs, technical efficiency can be calculated from equation (1):

$$\frac{\sum_{r=1}^{s} u_r y_r}{\sum_{i=1}^{m} v_i x_i} = \frac{u_1 y_1 + u_2 y_2 + ... + u_s y_s}{v_1 x_1 + v_2 x_2 + ... + v_m x_m}, \quad (1)$$

where:

y_r - effect value,

u_r - effect weight,

x_i - input value,

v_i - input weight.

For each object, a linear programming task is solved, in which the calculated efficiency factor takes the form of a maximised objective function and the optimised variables are the effect weights and the input weights. For input-oriented models in dual form, it takes the form (2)

$$\min_{\Theta,\lambda} \Theta, \tag{2}$$

under constraints (3):

$$\begin{aligned} \mathbf{Y}\boldsymbol{\lambda} &\geq \mathbf{Y}_{\mathbf{o}}, \\ \Theta\mathbf{X}_{\mathbf{o}} - \mathbf{X}\boldsymbol{\lambda} &\geq 0, \\ \boldsymbol{\lambda} &\geq 0. \end{aligned} \tag{3}$$

where:

$\mathbf{X}_o$ - the vector of inputs of a given units (of dimension [1 × m]),

$\boldsymbol{X}$ - the input matrix of all units (of dimension [n × m]),

$\mathbf{Y}_o$ - vector of effects of a given units (with dimensions [1 × s]),

$\boldsymbol{Y}$ - the matrix of effects of all units (with dimensions [n x s]),

$\lambda_1, ..., \lambda_\sigma$ - linear combination coefficients,

Θ - the efficiency measure of the unit.

The task was solved for all n objects. The aim of the optimisation performed was to find the minimum value of the efficiency coefficient for which it is possible to reduce inputs or resources without changing the effect level. When this is not possible, then $\Theta = 1$, which means that there is no more favourable combination that allows the object to achieve the same effects. The object is then said to be economically efficient. Conversely, when $\Theta < 1$, there is a more efficient combination of inputs that allows the facility to achieve the same effects. The parameter Θ determines what percentage of the inputs of the object under study is sufficient to achieve the current level of effects using efficient object technology. Information about the structure of the optimal combination of inputs and effects is provided by linear combination coefficients λ (Rusielik, 2017).

Banker, Charnes and Cooper in 1984 proposed an extension of the CCR model to the BCC model assuming variable scale effects (Banker, Charnes, Cooper, 1984). For this purpose, the CCR model can be modified by adding a convexity constraint 1'·λ=1, resulting in a model of the form (4):

$$\min_{\Theta,\lambda} \Theta, \tag{4}$$

with constraints:

$$\begin{aligned} \mathbf{Y}\boldsymbol{\lambda} &\geq \mathbf{Y}_{\mathbf{o}}, \\ \Theta\mathbf{X}_{\mathbf{o}} - \mathbf{X}\boldsymbol{\lambda} &\geq 0, \\ 1' \cdot \lambda = 1\boldsymbol{\lambda} &\geq, 0. \end{aligned} \tag{5}$$

Using the input-oriented BCC model and assuming variable economies of scale, the technical efficiency indicators of the 25 EU countries were calculated for the years 2007, 2015 and 2023. In the next step, an analysis of the development of the level of these indicators

in each group was performed and an attempt was made to find a specific unique pattern. The results of the measurement are shown in Table 3.

4. Research results

In the initial phase of the research, a general analysis of agriculture from 2007 to 2023 was carried out. The changes that took place over the years under study were analysed on the basis of the collected variables. In particular, attention was paid to the development of the volume of agricultural production, the individual costs of this production, changes in the area of production, productivity and also labour inputs were taken into account both in terms of hourly inputs (AWU) and labour costs (EUR). This part also analysed the possible impact of the European Union's agricultural policy on individual countries and the influence on the formation of separate groups (Table 2.). In the second part of the research, an attempt was made to assess the level of technical efficiency and changes in this efficiency in the individual isolated groups of countries. As mentioned, the research used the DEA method and the BCC model.

A. Agricultural development in the context of CAP impact

Based on the analysis of the trajectory of changes in individual variables, several groups of countries were identified. A summary of these groups according to the adopted characteristics is provided in Table 2. A characterisation of each group along with an attempt to estimate the impact of CAP mechanisms is illustrated below.

Group 1. Efficient innovators

Netherlands, Denmark, Belgium, Germany, United Kingdom*[1].

These countries are at the forefront of agricultural innovation in the EU. They have achieved high levels of productivity through advanced technologies and efficient agricultural practices. Despite the stabilisation of agricultural areas, they have managed to significantly increase production with moderate to low labour force decline.

Characteristics:

- Strong production growth.
- Significant increases in productivity (both per hectare and per AWU).
- Stable or declining agricultural area.
- Moderate or low decline in labour force.

Agricultural policy impact:

- Support for innovation: the EU programmes supporting research and development (e.g. Horizon, 2020) have enabled these countries to invest in advanced agricultural technologies.

[1] Due to Brexit, data up to 2020 has been included.

- Environmental standards: Stringent EU environmental standards have prompted these countries to develop sustainable, high-performance farming practices.
- Targeted subsidies: the CAP has gradually moved away from production-related subsidies, favouring efficient, innovative farms in these countries.

Group 2. Rapid modernisers

Poland, Romania, Bulgaria, Czech Republic, Hungary

This group, consisting mainly of Eastern European countries, showed the most dramatic changes. These countries have rapidly modernised their agricultural sectors, significantly reducing labour inputs while substantially increasing productivity. This suggests a large-scale adoption of modern farming techniques and possible farm consolidation.

Characteristics:

- High production growth.
- Large increases in productivity, especially in later years.
- Significant reduction in the agricultural labour force.
- Various changes in agricultural area.

Agricultural policy impact:

- Structural Funds: Significant support from the EU funds (e.g. EAFRD) has accelerated the modernisation of agricultural and rural infrastructure.
- Adaptation programmes: EU pre-accession and post-accession policies forced rapid adaptation to EU standards, stimulating modernisation.
- Direct subsidies: The introduction of direct subsidies increased farmers' incomes, enabling investment in modern technologies.

Group 3 Stable performers

France, Italy, Spain, Germany, Austria, Ireland, Sweden

These countries, many of which are long-standing members of the EU, have shown steady but moderate growth. They have struck a balance between modernisation and preserving existing agricultural structures. Their challenges often include adapting to new EU regulations and maintaining stability and competitiveness.

Characteristics:

- Moderate but steady increase in production.
- Gradual improvement in productivity.
- Slight to moderate decline in agricultural area and labour force.

Agricultural policy impact:

- Market stabilisation: CAP mechanisms (e.g. market interventions) helped to maintain price and production stability.
- Protection of regional products: The EU policies protecting geographical indications supported the countries' traditional, high-quality products.
- Sustainability: The EU agri-environmental programmes encouraged sustainable practices, maintaining a balance between production and environmental protection.

Table 2.
Summary of EU country groups by agricultural characteristics (2007-2023)

Group	Countries	Growth in production	Changes in agricultural area	Changes in labour force	Productivity growth	Other characteristics
1. Efficient innovators	Netherlands, Denmark, Belgium, Germany, United Kingdom*	Strong	Stable or declining	Moderate to low decline	Significant (per hectare and per AWU)	Highest production per hectare and per AWU. Significant technology adoption. Focus on high value crops.
2. Rapid modernisers	Poland, Romania, Bulgaria, Czech Republic, Hungary	High	Diversified	Significant reduction	Large, especially in later years	Dramatic improvement in labour productivity. Significant structural changes. Likely beneficiaries of EU agricultural policies.
3. Stable performers	France, Italy, Spain, Austria, Ireland Sweden, Finland	Moderate but consistent	Slight to moderate decline	Slight to moderate decline	Gradual	Sustained growth. Stabilised agricultural sectors. Adaptation to changing market conditions
4. Challenging adaptors	Greece, Croatia, Portugal, Slovenia, Slovakia	Inferior or inconsistent	Challenges in governance	Challenges in transformation	Lower	Various structural or economic challenges. Some show improvement in later years. Often specific geographical or economic constraints
5. Specific cases	Estonia, Latvia, Lithuania	Differentiated	Differentiated	Differentiated	Differentiated	Baltic countries: mixed trends, characteristics of groups 2 and 4

* Due to Brexit, data up to 2020 has been included.

Source: own research based on EUROSTAT data.

Group 4 Challenging adaptors

Greece, Croatia, Portugal, Slovenia, Slovakia

Countries in this group face different challenges, such as difficult geography, economic constraints or structural issues in their agricultural sectors. Although some show signs of improvement, they generally lag behind in terms of productivity growth and sector modernisation. Some show recovery or improvement in later years.

Characteristics:

- Lower or inconsistent production growth.
- Less improvement in productivity.
- Challenges related to farmland management or labour force change.

Agricultural policy impact:

- Support for disadvantaged areas: Special EU programmes helped to maintain agriculture in mountainous or disadvantaged areas.
- Restructuring programmes: The EU offered support in restructuring inefficient sectors (e.g. vineyards in Greece).
- Rural development: Rural development funds helped to diversify the rural economy, relieving pressure on the agricultural sector.

Group 5 Special cases

Estonia, Latvia, Lithuania

The Baltic countries (Estonia, Latvia, Lithuania): Showing mixed trends, they can be considered a subgroup between rapidly modernising countries and countries adapting to challenges.

Characteristics:

- diverse and mixed trends.

Agricultural policy impact:

- The Baltic countries have benefited from adaptation and modernisation programmes.

These groups provide an insight into different trajectories of agricultural development across the EU. They reflect not only economic and technological aspects, but also the impact of the EU policies, national strategies and regional characteristics on agricultural performance. This classification also shows how diverse agricultural development trajectories in the EU countries are and how differently the EU policies affect these processes, depending on the initial situation of the country and its specific circumstances.

It is worth noting that the impact of the EU policies has not been unilateral. Member countries also influenced the shaping of the CAP, leading to an evolution of the policy over time, taking into account different needs and challenges of various EU regions.

B. Technical efficiency of agriculture in groups of the EU countries distinguished by development trajectories

As noted earlier, several groups of countries were identified based on the analysis of the trajectories of change of individual variables. In the second stage of the research, using the BCC model, technical efficiency was measured and an attempt was made to find differences in the level and dynamics of change in technical efficiency between the identified groups of countries. The analysis shown in this article covers 2007, 2015 and 2023. The calculated technical efficiency indicators are shown in Table 3.

Analysing the development of efficiency indicators, it can be concluded that the level of agricultural efficiency in the EU is increasing. Most of the analysed groups tend to increase the level of the efficiency indicator, but each one shows unique patterns of change in this indicator. This may be due to differences in agricultural policies, investment levels, technology, and economic and climatic conditions.

Group 1. Efficient innovators

Netherlands, Denmark, Belgium, Germany, UK*[2]

These countries are characterised by high and stable efficiency, with little change over time, suggesting effective implementation of innovations and maintenance of high productivity.

Group 2. Rapid modernisers

Poland, Romania, Bulgaria, Czech Republic, Hungary

In this group, there is a noticeable improvement in the level of efficiency over time. Two countries, i.e. Poland and Bulgaria, show full efficiency over the analysed period, while the other countries show a significant improvement in efficiency levels. These countries show a tendency towards rapid modernisation and efficiency improvements, which may be the result of investments in technology and restructuring of the agricultural sector.

Group 3. Stable performers

France, Italy, Spain, Germany, Austria, Ireland, Sweden

Countries in this group are characterised by varying but relatively stable levels of efficiency. France, Italy and Spain maintain full technical efficiency. The other countries show little fluctuation in efficiency levels. This may be due to well-established agricultural practices and supportive policies.

Group 4. Challenged adaptors

Greece, Croatia, Portugal, Slovenia, Slovakia

Countries in this group show a visible improvement in efficiency levels over time. These countries show the ability to adapt and improve efficiency, although they may face challenges in maintaining stability. Portugal is an example here with the index of 0.868 in 2007, rising to 1.000 in 2015 but falling to 0.986 in 2023.

[2] * Due to Brexit, data from 2023 is not included.

Table 3.
Indicators of technical efficiency of agriculture in EU countries in 2007-2015

EU25	2007	2015	2023	Average
1. Efficient innovators				
Belgium	1,000	1,000	1,000	**1,000**
Denmark	1,000	1,000	1,000	**1,000**
Germany	0,997	1,000	1,000	**0,999**
Netherlands	1,000	1,000	1,000	**1,000**
United Kingdom	0,827	1,000	0,010	**0,914**
Average	**0,965**	**1,000**	**1,000**	**0,987**
2. Rapid modernisers				
Bulgaria	1,000	1,000	1,000	1,000
Czech Republic	0,834	0,851	0,872	0,852
Hungary	0,762	0,904	0,944	0,870
Poland	1,000	1,000	1,000	1,000
Romania	0,736	0,871	0,987	0,864
Average	0,866	0,925	0,961	0,917
3. Stable performers				
Austria	0,892	0,856	1,000	**0,916**
Finland	0,795	0,699	0,867	**0,787**
France	1,000	1,000	1,000	**1,000**
Ireland	0,854	0,959	0,896	**0,903**
Italy	1,000	1,000	1,000	**1,000**
Spain	1,000	1,000	1,000	**1,000**
Sweden	0,822	0,876	0,944	**0,880**
Average	**0,909**	**0,913**	**0,958**	**0,927**
4. Challenged adaptors				
Croatia	0,957	1,000	1,000	**0,986**
Greece	1,000	1,000	1,000	**1,000**
Portugal	0,868	1,000	0,986	**0,951**
Slovakia	0,856	1,000	1,000	**0,952**
Slovenia	1,000	1,000	1,000	**1,000**
Average	**0,936**	**1,000**	**0,997**	**0,978**
5. Special cases				
Estonia	1,000	1,000	1,000	**1,000**
Latvia	0,862	1,000	1,000	**0,954**
Lithuania	0,934	0,950	0,829	**0,904**
Average	**0,932**	**0,983**	**0,943**	**0,953**
Average total	**0,920**	**0,959**	**0,972**	**0,950**

Source: own research.

Group 5. Special cases

Estonia, Latvia, Lithuania

These countries are characterised by varying trends in efficiency, with Estonia and Latvia showing stability, while Lithuania experiencing a decline in efficiency in recent years.

Summarising the analysis of the development of the efficiency index, it can be concluded that most countries show an upward trend in efficiency. The countries in the 'High Efficiency Innovators' group show the most stable performance. The greatest improvement is seen in the 'Rapid Upgraders' and 'Challenged Adaptors' groups. The Baltic countries (group 5) show mixed trends, with the exception of Estonia maintaining stable efficiency. By 2023, the majority of countries have achieved high efficiency rates (>90%)

5. Recommendations

In order to improve the efficiency of agriculture in the different groups of countries in the European Union, different agricultural policies can be proposed to address the specific needs and challenges of each group. The recommendations for each of the identified groups are presented below:

Group 1: Efficient innovators

Netherlands, Denmark, Belgium, Germany

Recommended policies:

- Support for research and innovation: Increase funding for agricultural research to develop new technologies and practices that can increase productivity.
- Sustainability: Promote agricultural practices that are environmentally friendly, such as precision agriculture that minimises resource use. Support for projects related to a circular economy.
- Educational programmes: Training for farmers on new technologies and innovative farming practices.

Group 2: Rapid modernisers

Countries: Poland, Romania, Bulgaria, Czech Republic, Hungary

Recommended policies:

- Access to finance: Facilitate access to credit and grants for farmers to invest in modern technology and infrastructure.
- Support programmes for young farmers: Initiatives to attract young people to the agricultural sector, which can contribute to innovation and modernisation.
- Cooperation with the environment: Encourage consolidation and partnerships between farmers and technology companies to implement modern solutions.

Group 3: Stable performers

France, Italy, Spain, Austria, Sweden, Ireland, Finland

Recommended policies:

- Preserving traditional practices: Promote local agricultural traditions that can be sustainable and efficient.
- Quality certification schemes: Support for the introduction of certification schemes that promote the quality of agricultural products, which can increase their market value.
- Sustainability: Support agricultural practices that are sustainable to maintain production stability. Support for producer groups.

Group 4: Challenged adaptors

Greece, Croatia, Portugal, Slovenia, Slovakia

Recommended policies:

- Support for climate change adaptation: Programmes that help farmers adapt to changing climate conditions, such as training in sustainable water management.
- Investment in infrastructure: Improve infrastructure, such as irrigation systems, to increase production efficiency.
- Promoting crop diversity: Encourage the cultivation of a variety of crops, which can increase resilience to climate and market changes.

Group 5: special cases

Estonia, Latvia, Lithuania

Recommended policies:

- Support for the development of local markets: Initiatives to develop local markets for agricultural products, which can increase farmers' incomes.
- Education and training programmes: Training for farmers in modern farming practices and farm management.
- Increasing access to technology: Facilitate access to modern technologies and tools that can help increase production efficiency.

Each group of countries in the EU has its own unique challenges and opportunities. The implementation of appropriate agricultural policies that take into account the specificities of each group can contribute to improving the efficiency of agriculture across the EU. It is also crucial to monitor and evaluate the effectiveness of these policies to adapt them to the changing conditions and needs.

6. General conclusions

Based on the analysis of the technical efficiency of agriculture in the European Union countries from 2007 to 2023, taking into account the impact of the Common Agricultural Policy (CAP), general conclusions can be drawn:

- The analysis showed an overall increase in the technical efficiency of agriculture in the EU over the period studied. Most member countries achieved high efficiency rates, suggesting a positive impact of CAP reforms and investments in modern technologies. In particular, country groups such as the 'Productive Innovators' and 'Rapid Modernisers' showed significant progress in efficiency, which may be the result of successful implementation of innovation and adaptation to changing market conditions.

- There is a clear variation in technical efficiency levels between different country groups. Countries in the 'Efficient Innovators' group (e.g. Netherlands, Denmark, Germany) have achieved the highest efficiency rates, while the 'Challenged Adaptors' (e.g. Greece, Croatia) face a variety of structural and economic challenges, which affect their ability to improve efficiency.
- The CAP has played a key role in shaping the technical efficiency of agriculture in the EU. Policy reforms, such as the introduction of direct payments and rural development programmes, have contributed to increased investment in modern technologies and improved living conditions in rural areas. However, these effects have varied depending on the specific characteristics of the countries and their initial circumstances.
- Against the backdrop of increasing challenges related to food security, climate change and sustainability pressures, agriculture in the EU needs to adapt to new realities. The implementation of green transformation and the digitalisation of agriculture is becoming crucial for the further development of the sector. Countries that successfully implement innovative agricultural practices will be more likely to achieve long-term efficiency.
- The conclusions of the analysis point to the need for further research on the technical efficiency of agriculture in the context of changing market and policy conditions. It is important for the EU agricultural policy to be flexible and adapt to local needs and country specificities. In the future, it will also be necessary to diversify support instruments to better respond to the challenges and needs of different groups of countries.
- Investment in R&D and knowledge transfer is crucial to increasing technical efficiency in agriculture. Countries that make effective use of technological innovation and support the development of human capital are more likely to achieve high production efficiency. Cooperation between member countries in sharing experiences and best practices can further increase efficiency across the EU.
- The future of agriculture in the EU will largely depend on the ability of countries to adapt to the changing market, technological and environmental conditions. The balance between production and environmental protection will be vital, which requires innovative solutions and the involvement of all stakeholders in decision-making processes. The Common Agricultural Policy should continue its reforms to effectively support farmers in adapting to these challenges.

In conclusion, the analysis of the technical efficiency of agriculture in the EU between 2007 and 2023 shows positive trends, but also variation in performance between countries. The Common Agricultural Policy is crucial for the further development of the sector, but requires continuous adaptation and innovation to meet today's challenges. These findings and recommendations can form the basis for shaping the future EU agricultural policy and agricultural development strategies in individual Member States.

7. Summary

The study analyses the technical efficiency of agriculture in the European Union countries for the 2007-2023 period, taking into account the development paths in each country and the impact of the Common Agricultural Policy. A set of variables was adopted that reflects the specifics of the business model of agricultural production and is also relevant to the analysis of technical efficiency. In the first stage of the research, on the basis of observations and analysis of the trajectory of the adopted variables, five groups of countries with similar development paths and efficiency were identified. An attempt was made to estimate the impact of different CAP instruments on the formation of these paths. In the second stage, the Data Envelopment Analysis (DEA) method was used, which, in the context of the adopted variables, allowed for an accurate assessment of the technical efficiency of agriculture, taking into account differences in the structure of production and the level of technological development. The results indicate a general upward trend in technical efficiency in the EU agriculture, but with marked differences between the separate groups of countries. The study also showed that the impact of the CAP on technical efficiency varies and depends on the initial conditions and development strategies adopted in each country. The results of the study made it possible to formulate recommendations aimed at raising and levelling the efficiency levels.

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THE IMPORTANCE OF COMPETENCIES CERTIFICATION FOR PROFESSIONAL DEVELOPMENT – STUDENT'S PERSPECTIVE BASED ON IPMA-STUDENT CERTIFICATION EXAMPLE

Joanna RZEMPAŁA[1*], Marcin OPAS[2], Aleksander OBERNIKHIN[3]

[1] University of Szczecin; joanna.rzempala@usz.edu.pl, ORCID: 0000-0002-0542-9370
[2] Kozminski University, Warsaw; mopas@kozminski.edu.pl, ORCID: 0000-0003-3941-1846
[3] Warsaw University of Technology; 45419@kozminski.edu.pl, ORCID: 0009-0007-6226-6292
* Correspondence author

Purpose: The primary aim of the research was to investigate the motivations, demographic characteristics, and career outcomes of participants in the IPMA-Student certification program. The study sought to understand what drives students and young professionals to pursue certification, how their educational background and professional aspirations influence this decision, and what barriers may limit their progression to higher certification levels. By doing so, it aims to highlight the role of certification in early career development. It provides educators, employers, and certification organizations insights to support young professionals' professional growth.
Design/methodology/approach: The research objectives were achieved through a combination of literature review and empirical data collection, focusing on the IPMA-Student certification program. The paper's theoretical and subject scope focus on the significance of professional certification, particularly the IPMA-Student certification, in developing competencies for students and early-career professionals.
Findings: The research revealed several key insights into the motivations, demographics, and career impacts of the IPMA-Student certification for students and early-career professionals.
Research limitations/implications: The research focused specifically on the IPMA-Student certification program in Poland. This narrow scope may only partially reflect trends in project management certification in other countries or within different certification frameworks.
Practical implications: The research underscores the importance of recognizing certifications as a skill benchmark and offering support (e.g., funding or incentives) for employees to pursue them.
Social implications: The data suggests that certifications significantly support gender equality in the workplace by empowering women to overcome barriers like the "glass ceiling".
Originality/value: The paper offers a detailed examination of the IPMA-Student certification, a relatively understudied area within project management certification. This paper is valuable to several audiences, such as students and early-career professionals, educators and universities, certification bodies, employers, researchers, and policymakers.
Keywords: professional certification, competencies, IPMA.
Category of the paper: Research paper.

1. Introduction

Employers increasingly value industry-recognized certifications to assess candidate competencies and readiness for professional roles in today's competitive job market. For students and early-career professionals, certifications can serve as vital tools for bridging the gap between academic learning and industry standards, validating theoretical knowledge and practical skills. In project management, where effective planning, execution, and evaluation are essential, certifications such as IPMA-Student offer individuals a structured path to demonstrate their capabilities.

The International Project Management Association (IPMA) Poland developed the IPMA-Student certification to introduce students and young professionals to core project management competencies. While project management skills are widely applicable across industries, their structured validation through certification provides an advantage in fields that demand strong project coordination, such as information technology, finance, consulting, and engineering. Certification can signify a dedication to personal development that resonates with employers, especially in environments prioritizing accountability, leadership, and team coordination.

Research into students' motivations for certification often emphasizes "career advancement" as a primary driver. Studies indicate that students see certifications enhancing their marketability, potentially leading to higher salary prospects, promotions, or access to specialized project roles. Additionally, certifications offer intrinsic benefits, contributing to personal growth and professional identity development. However, while the benefits are recognized, factors like cost, time investment, and perceived value among employers can influence students' willingness to pursue or continue with certification programs.

This study investigates the motivations, demographic characteristics, and career outcomes of IPMA-Student certification participants, exploring how these factors shape their decisions to pursue or upgrade their certifications. Using survey data from 129 IPMA-Student participants, this research seeks to answer key questions: What are the primary motivations driving students and young professionals to certify? How do educational background and professional goals influence the decision to pursue project management credentials? Moreover, what challenges limit the progression to advanced certification levels?

This study contributes to a better understanding of certification's role in early career development by identifying the motivations and barriers faced by IPMA-student certification holders. It also highlights the potential for certifications to empower students and young professionals, particularly women, who use these credentials to enhance competitiveness and break into traditionally challenging career paths. The findings provide valuable insights for educators, employers, and certification bodies aiming to support young professionals in their journey toward career readiness and professional growth.

2. Review of the literature

2.1. The Needs of Students in the Area of Professional Competencies Certification

As the industrial era progressed to the post-industrial era, production shifted from material to intellectual. This transition significantly increased workers' demands, particularly regarding their competencies. The surge in the need for specialists with formal education, typically obtained from universities, was instrumental in preparing students for narrow specializations required for single-task production. However, the evolution of production products necessitated a broader set of competencies (Chemodanova et al., 2021).

Modern specialists find that their undergraduate or graduate-level knowledge needs to be improved to address complex problems in practice adequately. For instance, only 54% of respondents in a study by (Chemodanova et al., 2021) felt that higher education thoroughly prepared them for professional activities. The content of the disciplines included in educational programs does not meet employers' expectations regarding gained professional competencies. According to (Bogdanova, Slepneva, 2020), applying knowledge from different disciplines and merging ideas and methods from various sources is crucial. The knowledge gained at the university can be considered soft skills, emphasizing the ability to process and analyze information. Therefore, many employers value students' soft skills, such as teamwork and cross-cultural management, whereas, at the same time, they see the completion of university education as a good foundation for further training in more specific, hard skills, which are an essential part of a good specialist's competencies (Andrade et al., 2020). The need for various competencies, especially hard ones, results in novice specialists adapting to current educational trends by pursuing appropriate higher education and other methods of self-improvement (Kizi, 2022). Universities transform students from passive listeners to active, creative subjects of learning who independently undertake training courses and other educational activities (Toroev, Rasulova, 2023) and (Fry et al., 2008) have shown how students' skills of independent work acquired during university turn into their inner need to prepare themselves for professional activities, going through four stages:

- Level 1: Gaining knowledge of objects through comprehension of previously mastered material and performing simple actions based on them.
- Level 2: Reproducing actions following a pattern.
- Level 3: Reproducing actions in one's manner using critical thinking.
- Level 4: Performing activities aimed at independent learning.

Figure 1. Four stages of developing the need for learning.

Source: own figure based on (Fry et al., 2008).

As the market conditions have led employees to seek new educational opportunities beyond university, informal education is distinguished as a popular and independent category. Informal education is purposeful and planned, complementing formal education or sometimes even serving as its alternative. It can take the form of intensive training programs, workshops, and massive open online courses provided by specialized institutions or organizations (Chemodanova et al., 2021). Corporate training has recently become popular because rapid changes in the informational, technological, economic, and socio-cultural spheres have led to graduates being seen not as ready specialists but as potential resources. According to employers, a fully-fledged specialist is formed through actual practical activities in the workplace (Chemodanova et al., 2021).

Informal education often includes issuing a document confirming the training results, such as certification. Certification is essentially designed to verify that a person possesses the knowledge and experience necessary to perform their duties according to their chosen field's standards and ethical approaches (Pettersson, 2017).

2.2. Certification of Project Management Skills – IPMA-Student Model

Over the past years, numerous project manager competency models have emerged, aiming to define and assess the knowledge, skills, and abilities crucial for success in project management (Chen et al., 2008; Takey, Carvalho, 2015). However, the International Project Management Association Competence Baseline (ICB) is the only globally recognized and formalized project manager assessment (certification) body.

The ICB does not discuss competencies in terms of specific roles (e.g., project manager) but rather in terms of the domain (e.g., individuals working in project management). The rationale is that roles and role titles vary significantly by language, industry, and focus. Therefore, the ICB presents competencies essential for project management, program management, and portfolio management. Each domain may contain roles and titles that fit the overall competence domain. ICB is organized into three areas: technical competencies, behavioral competencies, and contextual competencies (*IPMA Individual Competence Baseline. Ver. 4.0.1.*, 2015).

Figure 2. IPMA's Eye of Competence.

Source: https://ipma.world/app/uploads/2023/01/IPMA_Individual_Standard_ICB4_assesment_areas-768x768-1.jpg)

According to ICB, people competencies are personal and interpersonal competencies required to participate successfully in or lead a project, program, or portfolio. Practice competencies are the specific methods, tools, and techniques used in projects, programs, and portfolios to realize their success. Perspective competencies are methods, tools, and techniques through which individuals interact with the environment and the rationale that leads people, organizations, and societies to start and support projects, programs, and portfolios. Within each competence area, generic competence elements (CE) apply to all domains. CEs contain lists of the pieces of knowledge and skills required to master the CE. Key competence indicators (KCI) provide the definitive indicators of successful project, program, and portfolio management for two or all three domains. Measures exist that describe highly detailed performance points in each KCI.

Competence in the project domain is broken into 28 CE with one to many KCI each.

Area No.	CE No.	Description
4.3 Perspective	4.3.1	Strategy
	4.3.2	Governance, structures and processes
	4.3.3	Compliance, standards and regulations
	4.3.4	Power and interest
	4.3.5	Culture and values
4.4 People	4.4.1	Self-reflection and self-management
	4.4.2	Personal integrity and reliability
	4.4.3	Personal communication
	4.4.4	Relationships and engagement
	4.4.5	Leadership
	4.4.6	Teamwork
	4.4.7	Conflict and crisis
	4.4.8	Resourcefulness
	4.4.9	Negotiation
	4.4.10	Result orientation
4.5 Practice	4.5.1	Project design
	4.5.2	Requirements and objectives
	4.5.3	Scope
	4.5.4	Time
	4.5.5	Organization and information
	4.5.6	Quality
	4.5.7	Finance
	4.5.8	Resources
	4.5.9	Procurement
	4.5.10	Plan and control
	4.5.11	Risk and opportunity
	4.5.12	Stakeholders
	4.5.13	Change and transformation

Figure 3. IPMA project KCIs

Source: own figure based on (*IPMA Individual Competence Baseline. Ver. 4.0.1.* , 2015)

To assess the project manager's competency, IPMA developed the IPMA Four-Level Certification (IPMA 4-L-C), where assessors trained in the IPMA certification assessment process evaluate a candidate's level of competence. The IPMA 4-L-C System operates in three domains: project, program, and portfolio management, and has four levels of competence.

		Domain		
Level		**Project**	**Programme**	**Portfolio**
	A	Certified Project Director	Certified Programme Director	Certified Portfolio Director
	B	Certified Senior Project Manager	Certified Senior Programme Manager	Certified Senior Portfolio Manager
	C	Certified Project Manager		
	D	Certified Project Management Associate		

Figure 4. IPMA 4-L-C system profiles.

Source: own figure based on (*IPMA Individual Competence Baseline. Ver. 4.0.1.*, 2015).

Applicant eligibility criteria and areas of responsibility expected for project, program, and portfolio management are identified for each role.

The project manager assessment process may vary depending on the certification level and National Certification Body regulations. This research is related to Polish rules and procedures (*IPMA Polska Certyfikacja; Https://Ipma.Pl/Certyfikacja/*, 2024). At level D, designed for individuals new to project management or with limited experience, the certification process involves completing a written exam and a self-assessment, which evaluate the individual's project management knowledge and skills. Level C is designed for project managers with several years of project management experience, and the certification process involves completing a written exam and assessment center (or individual interview). Level B is designed for senior project managers who have significant project management experience and have managed complex projects. The certification process involves completing a written exam, report, and an assessment center (or an individual interview). Level A is designed for individuals with extensive experience managing multiple projects or programs. The certification process involves the presentation of recommendation letters, a written report summarizing project management experience, and an assessment center.

In 2013, the International Project Management Association Poland (IPMA Poland) launched work on the accreditation system of educational programs and assumptions for certification of students in project management. Those actions resulted in developing the IPMA-Student Program, which has been jointly applied since 2014. The IPMA-Student competency model is based on ICB. It defines and standardizes the project management competencies a student should possess to be prepared for active and practical work in a project team and as a project manager. IPMA-Student includes 26 out of 28 ICB CEs, with two CEs excluded: Procurement (4.5.9) and Change & Transformation (4.5.13).

Through the IPMA-Student accreditation program, IPMA Poland offers universities the opportunity to confirm the compliance of education programs in project management, implemented as part of first and second-degree studies, with the competence requirements of the IPMA ICB standard. This also means unifying vocabulary and concepts related to project management and the possibility of using standard teaching tools. In addition, a network of coordinators appointed at universities enables students to verify and certify their competencies.

3. Methodology

Literature research included articles in the EBSCO, Web of Science, and ProQuest databases. Entries related to competencies and project manager certification were filtered. The following terms were analyzed: "student certification in project management", "student professional certification", and "popularity of certification among students". About 90 items were accepted for analysis. In addition, the authors of the article utilized data gathered in research university graduates' experience with the IPMA-Student certificate conducted in 2021 (Rzempała et al., 2023).

As part of the initiative, graduates' opinions were analyzed regarding the usefulness of both the certification itself and the importance and usefulness of accreditation in professional work. The study participants were people who passed the IPMA-Student exam from 2016 to February 2021. The questionnaire was sent to 964 people. Some e-mail addresses (76) from the IPMA-Student Portal, the tool for conducting exams, were already inactive.

The survey questionnaire was sent from March to July 2021 using the GetResponse tool. To reach better, it was decided that invitations to participate in the survey would be sent three times: on March 9, April 27, and June 2. The total number of openings of the e-mail containing the link to the survey was 724, of which 155 receivers (from three mailings) clicked the survey link.

As a result, 129 correctly completed surveys were received. Table 1 presents the process of sending survey e-mails at different times, indicating the detailed sending rates. MS Office 365 Excel software was used to develop the analysis results. Basic statistical analyses were performed. The group was purposeful and complete.

Table 1.
Reports of communication with the target group

Action	1st mailing	2nd mailing	3rd mailing
Number of emails sent	964	849	673
Number of emails delivered	888	802	626
Number of emails opened	339	260	125
The number of clicks on the hyperlink to the survey	81	46	28

Source: Own study based on reports generated via the GetResponse tool.

Participants provided information about their educational background, job sector, career motivations, and reasons for pursuing certification. The survey also explored participants' professional development activities, including their involvement in industry-specific networks and intentions regarding further certifications.

4. Research results

The study involved 129 individuals who completed the IPMA-Student course. Most IPMA-Student participants were pursuing or have completed higher education degrees, with a notable concentration at the master's level (52 participants). Additionally, many participants were engaged in postgraduate studies (30 participants), indicating interest in specialized knowledge and professional growth.

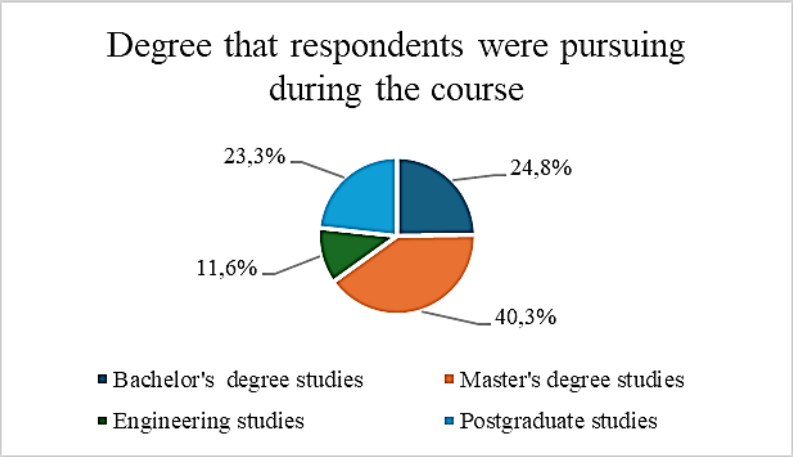

Figure 5. Study participants broken down by the degree of study.

The respondents group had a strong representation of women (82 out of 129), particularly among participants who chose to upgrade their certification to higher levels. Geographically, the program was most popular in regions with active project management communities, such as Zachodniopomorskie and Mazowieckie, highlighting possible regional variations in certification awareness and accessibility.

The respondents differed in their fields of study. Most came from management-related disciplines (80), especially project management, but there was also significant representation from technical fields such as IT and telecommunications. This variety suggests that the certification appeals to students in fields where project management principles are to career success.

The participants attended the course variously over eight years: 26 people completed the IPMA Student program in 2021, 20 in 2020, 24 in 2019, 24 in 2018, 12 in 2017, 9 in 2016, 13 in 2015, and 1 in 2014. Extrapolating this data, it can be stated that an increasing number of

individuals are enrolling in the course. This trend suggests a hypothesis that the market, along with the demands for employee competencies, is evolving and growing, prompting more students and even employees to pursue further training. A noticeable increase began from 2018 onward.

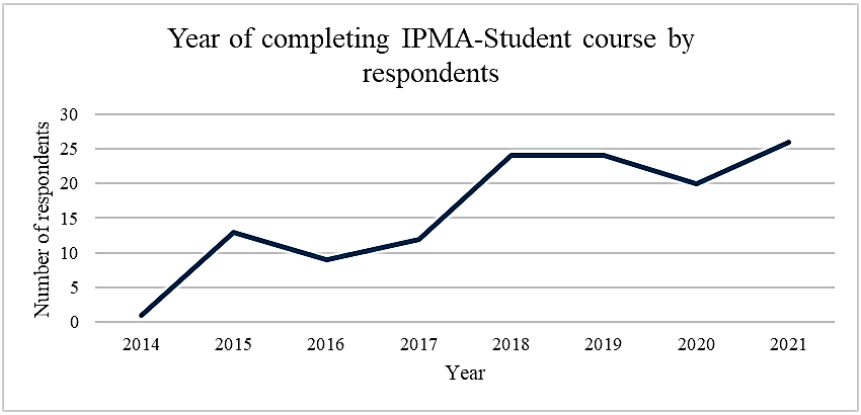

Figure 6. The distribution of course completion dates among the participants.

Most participants (82) were employed full-time, often in project-driven sectors where the certification is highly relevant. A smaller portion consists of part-time employees or interns who might be building foundational skills in project management as they begin building their careers. However, a significant segment of students (25) were still in formal education and were preparing to enter the workforce with certified project management skills.

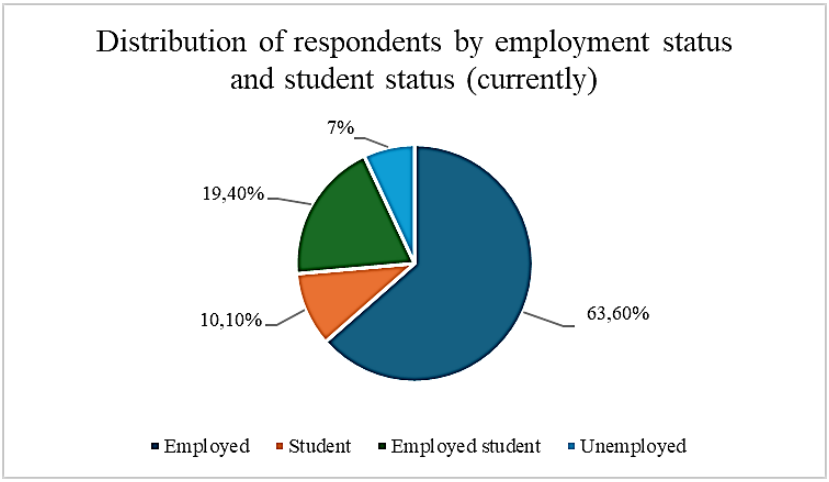

Figure 7. Study participants broken by employment and student status

The correlation between whether employers require a project management certification during recruitment is interesting. With only nine respondents indicating that their employers required certification, it appears that most participants pursued the IPMA-Student certification on their initiative rather than due to direct employer requirements. This suggests that, for the majority, certification may be a personal investment in career growth rather than a specific hiring prerequisite.

The primary motivation for participants was to enhance their competitiveness in the job market. Over 70% of participants pursued IPMA-Student certification as a personal investment in career growth rather than an employer-imposed requirement. This shows that students and early-career professionals increasingly recognize the importance of project management certification for achieving long-term career goals, even if their current roles do not explicitly demand it. Almost 23% of participants viewed IPMA-Student certification as a valuable credential that differentiates them from peers, particularly in industries where project management skills are critical. The research results confirm that the certification offers students an opportunity to formally validate their project management skills, as for more than 50% of respondents, the IPMA-Student credential is a structured way to benchmark their competencies against industry standards, which can boost their confidence in managing projects and improve their marketability to employers. This is particularly beneficial in technical and management fields where formal skills verification is valued. With a large portion of participants (38%) working in project-driven sectors like IT, finance, and consulting, the certification probably helps students prepare for project-oriented roles. For those already working part-time or as interns, the certification may complement their hands-on experience and signal readiness for more complex responsibilities.

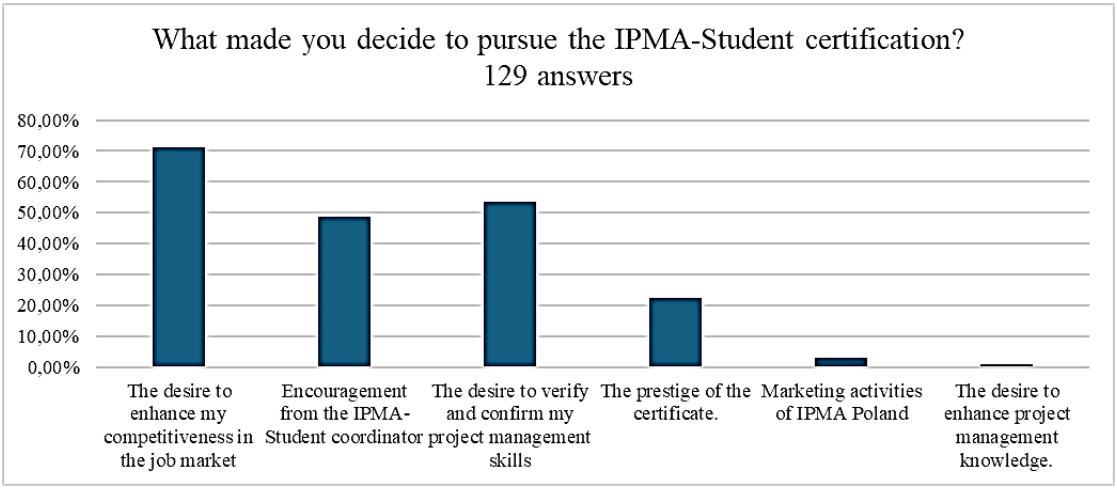

Figure 8. What made you join the IPMA-Student program?

The data reveals that more than 70% of students who pursued the certification are also involved in other professional development activities, such as additional coursework, workshops, or industry events. Certification seems to be part of a broader commitment to continuous learning and skill acquisition, suggesting that students view it as one component of their professional development strategy.

One of the key indicators confirming students' appreciation of IPMA certification value would be acquiring higher levels of certification. Interestingly, only 10% of students got further certified (12 at IPMA-D and one at IPMA-C level). Even though the dataset is significantly too small, analyzing the data on individuals who upgraded their IPMA-Student certification, several key trends emerged. Those who upgraded their certification are strongly oriented towards career

development. The most frequently cited motivation was the desire to increase their competitiveness in the job market. This may suggest that IPMA-student certification was seen as a tool for gaining a professional edge and improving career prospects. Most respondents (7) held a master's degree, indicating that individuals with higher education levels are more inclined to enhance their qualifications through certification further. Additionally, many were in project management-related fields, showing that certification is desirable to those already engaged in this area. Many respondents (54%) who upgraded their certification did so as part of postgraduate studies. This points to a trend where individuals continuing their education at the postgraduate level are more likely to invest in additional certifications to enhance their competencies and appeal in the job market. Women dominate this group, which may indicate a greater readiness or need among women to improve their qualifications in project management. This could also reflect broader professional trends where women seek to level their opportunities in the job market through additional qualifications. Those who upgraded their certification often earn above 6000 PLN gross. This may suggest that higher-income individuals see certification as an investment that can bring further financial benefits or that their earnings increase after obtaining it.

Due to the limited dataset of individuals who upgraded their certification, the authors analyzed "non-upgraders" and sought potential correlations that could provide more reliable conclusions. In terms of motivation for certification, similarly to those who upgraded their certification, the most common motivation among this group was the desire to increase their competitiveness in the job market. However, those who did not upgrade were more likely to mention external factors, such as encouragement from the IPMA-Student coordinator. Often, a combination of motivations was noted, suggesting that the decision to pursue certification was multifaceted. Considering the type of studies, the individuals who did not upgrade their certification most frequently pursued it as part of their master's degree studies. This aligns with the general trend that the IPMA-Student certification is popular among individuals at higher educational levels. Looking at the year of graduation factor, it turns out that respondents who did not upgrade their certification mostly graduated between 2018 and 2020. This suggests that the decision not to upgrade might be linked to the recent completion of education and possibly a lack of immediate need or experience to enhance their qualifications further. This group also predominantly studied management-related fields, but there was more diversity in their areas of study. This could suggest that individuals with a broader range of educational backgrounds pursue certification but may not consider upgrading it. Women also dominated this group (72 women compared to 44 men). This might indicate a broader trend where women are more likely to pursue certification but do not always choose to upgrade it. Most of those who did not upgrade their certification held a master's degree. This is consistent with the overall trend that individuals with higher levels of education are more likely to pursue certification but not necessarily to upgrade it. Furthermore, salaries in this group were varied. Still, most individuals earned over 6000 PLN gross, similar to "upgraders" which disproved the

hypothesis that higher-income individuals see certification as an investment. However, this may suggest that these individuals may already be well-compensated despite not upgrading their certification. This could indicate less perceived need for further qualification enhancement.

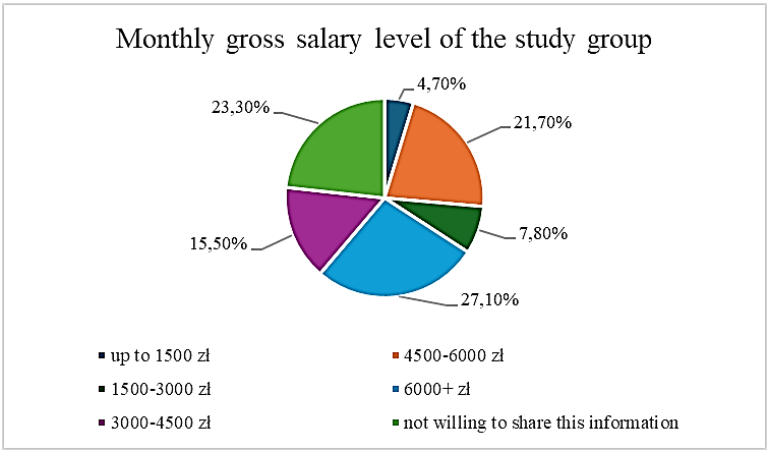

Figure 9. Monthly gross salary level of the study group.

Finally, the authors analyzed the reasons given by respondents for not upgrading their IPMA-Student certification. As a result, the following list was developed:

- lack of time was the most common reason, cited by 15 respondents, indicating that time constraints prevented them from pursuing an upgrade,
- 12 respondents mentioned that upgrading the certification was not necessary for their current job, suggesting that they did not see a direct benefit in their professional roles,
- the cost of certification was a significant barrier, with seven respondents citing it as the primary reason and ten others mentioning it alongside other factors like not needing it for their job,
- some respondents (6) stated that their employer did not require the certification, reducing their incentive to upgrade,
- a few respondents (6) also mentioned that the IPMA certification is not well recognized, which diminished its perceived value and usefulness,
- several respondents provided multiple reasons, such as cost, time constraints, and lack of necessity for their job. For example, eight respondents mentioned both cost and time as barriers,
- some respondents had specific reasons, such as focusing on other certifications (like TENSTEP), the impact of the COVID-19 pandemic, or waiting for a more opportune time in the future.

These reasons indicate that practical considerations, such as time, cost, and relevance to their current job, most significantly influence the decision not to upgrade the certification.

5. Discussion and Conclusions

The analysis of the obtained data shows that most students who take the IPMA-Student certification are active in other initiatives and forms of non-formal education, such as science clubs, internships, or conferences. Obtaining the certificate and the related increase in competitiveness in the labor market are the main motivations declared by students taking the IPMA-Student certification. Based on the research results, several key trends emerge.

Career Competitiveness and Differentiation

The data indicates that a primary motivation for pursuing the IPMA-Student certification is to increase "competitiveness in the job market." Many students and early-career professionals view certification as a way to stand out from peers, especially in fields where project management skills are highly valued. This aligns with the fact that, although only nine respondents reported employer certification requirements, most pursued certification proactively to enhance their employability and skillset.

Skill Validation and Professional Development

The certification allows students to formally "validate their project management skills". For many, the IPMA-student credential is a structured way to benchmark their competencies against industry standards, boosting their confidence in managing projects and improving their marketability to employers. This is particularly beneficial in technical and management fields where formal skills verification is valued.

Most respondents held at least a master's degree, which suggests that higher education students are more inclined to develop their qualifications further through certification. Additionally, many of these individuals were from project management-related fields, indicating that certification is desirable to those already engaged in this area. Many respondents who chose certification did so during or after postgraduate studies. This points to a trend in which those pursuing postgraduate education are more inclined to invest in additional certifications to enhance their competencies and marketability. Certifications are a natural career step for individuals advancing into senior management roles.

Preparation for Project-Oriented Roles

Many participants work in project-driven sectors like IT, finance, and consulting, so the certification helps students prepare for "project-oriented roles." For those already working part-time or as interns, the certification complements their hands-on experience and signals readiness for more complex responsibilities.

Proactive Career Growth

Many participants pursued IPMA-Student certification as a “personal investment in career growth” rather than an employer-imposed requirement. This shows that students and early-career professionals increasingly recognize the importance of project management certification for achieving long-term career goals, even if their current roles do not explicitly demand it. Most of these individuals are postgraduate students, and the most significant portion declared the highest income bracket. This may suggest that those advancing their qualifications aimed to move into higher positions, such as middle or top-level management, or to transition from operational to managerial roles.

Enhanced Professional Development Orientation

The data reveals that many students who pursued the certification are also involved in other “professional development activities”, such as additional coursework, workshops, or industry events. Certification seems part of a broader commitment to continuous learning and skill acquisition, suggesting that students view it as one component of their professional development strategy.

The IPMA-Student certification is of considerable importance for students and early-career professionals to meet immediate job requirements and as a strategic step toward building a competitive, well-rounded skill set. For most participants, it represents an investment in future career opportunities, professional credibility, and industry readiness, regardless of whether it is a formal requirement. Thus, the certification is valued primarily as a proactive tool for skill enhancement and career differentiation.

Gender Differences

Women dominate the group of individuals who upgraded their certification. This may suggest a greater readiness or need among women to enhance their qualifications in project management. Women are also more likely to pursue equal job opportunities and break the so-called "glass ceiling" by obtaining additional qualifications. Responses to salary questions indicate that these are mainly women with work experience who view certification as an investment leading to further financial benefits. However, some individuals who also upgraded did not disclose their earnings, which may suggest other motivations independent of monetary gain. When asked about their motivations for certification, respondents indicated the potential of using IPMA to gain a professional advantage and improve career prospects. It can also be suggested that IPMA's prestige and marketing activities serve as a desirable asset for those starting their careers.

Certification Timeline

All individuals who upgraded their IPMA level completed only the basic (D) level in 2017 or later. None of the earlier graduates among respondents continued their studies, which may suggest that IPMA certification was less popular 7-8 years ago than it is now. This may be attributed to lower globalization at that time, which drove fewer competency requirements in the workplace. However, only some individuals upgraded their certification from IPMA D to higher levels. They felt less need for accreditation or were satisfied with their current career status and earnings. It is also possible that their initial motivation for IPMA D came solely from encouragement by a program coordinator rather than intrinsic motivation.

6. Study Limitations and Future Research

This study provides insights into the motivations and career impacts of IPMA-student certification among students and early-career professionals. However, several limitations should be acknowledged. First, the sample size is relatively limited, and the study's participants are drawn from a specific certification program, which may only partially represent the diversity of students and professionals pursuing project management certifications globally. This limits the generalizability of the findings to other regions and certification programs.

Second, the study relies on self-reported survey data, which may introduce bias, as respondents may provide socially desirable answers or be influenced by retrospective evaluation of their career motivations and outcomes. Additionally, while the study explores motivations for certification, it does not capture detailed longitudinal data on participants' career trajectories over time, which would provide a more comprehensive understanding of how certification impacts long-term career development.

The study’s findings highlight several potential directions for future research. Expanding the sample size and diversity, including participants from multiple regions and various certification programs, would improve the generalizability of results and help identify trends across different demographic and industry contexts. A longitudinal study tracking certification holders over time would also provide valuable insights into the sustained impact of certification on career advancement, role transitions, and income growth.

Furthermore, future studies could explore the role of certification in helping professionals overcome specific career barriers, such as gender-related challenges or "glass ceiling" effects. Research focused on how certification influences career paths in particular industries, such as IT, healthcare, and engineering, where project management skills are highly sought after, would also be beneficial. Finally, examining the cost-benefit analysis from participants' perspectives, particularly how perceived financial and time investments influence certification pursuit and progression, could inform strategies for certification bodies and educational institutions to support and encourage certification uptake.

By addressing these limitations and exploring these areas, future research can contribute to a deeper understanding of certification's role in professional development, providing valuable insights for students, educators, employers, and certification organizations.

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DIFFERENCES IN LOCAL DEVELOPMENT CONDITIONS IN LAND COUNTIES IN POLAND DEPENDING ON CHANGES IN THE NUMBER OF THEIR RESIDENTS

Mirosław SOŁTYSIAK[1*], Dariusz ZAJĄC[2]

[1] Rzeszow University of Technology; miroslaw@prz.edu.pl, ORCID: 0000-0003-3366-1537
[2] University of Rzeszow; dzajac@ur.edu.pl, ORCID: 0000-0001-7918-1366
* Correspondence author

Purpose: The aim of the article is to identify and evaluate selected endogenous conditions of local development in rural districts in Poland, depending on changes in the number of their inhabitants.
Design/methodology/approach: The article identifies and assesses selected endogenous conditions of local development in rural districts in Poland, depending on changes in the number of their inhabitants. The empirical material of the article concerns all land districts in Poland. The numerical data come from the Local Data Bank of the Central Statistical Office in Warsaw and concern 2023. The collected and organised empirical material was developed in descriptive, tabular, and graphic form, using the method of comparative analysis. Furthermore, the article provides a point assessment of the diagnostic features illustrating the conditions of local development in separate groups of land counties in Poland depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country in 2023.
Findings: The statistical data carried out in the article confirmed the research hypothesis, assuming that the conditions of local development vary between land counties in Poland, depending on changes in the number of their inhabitants, with the best conditions in the group of counties characterised by an increase in this number.
Originality/value: The originality of the work lies in the approach to the analysis of the research issues undertaken. For the purposes of the research, the article included a point assessment of the diagnostic characteristics analysed diagnostic features illustrating the conditions of local development in separate groups of land counties in Poland depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country in 2023. The work is addressed to local government officials responsible for the conditions, possibilities and directions of local socio-economic development of poviat local government units in Poland, as well as to other decision-makers involved in the implementation of local development policy.
Keywords: local development, endogenous development conditions, land countries in Poland, changes in the number of inhabitants.
Category of the paper: research paper.

1. Introduction

Research issues related to socioeconomic development on a regional and local scale have arouse wide interest among economists. The main reasons for this are the danger of disappearing the specific features of regions and local environments, their cultural identity and historical heritage, as well as the growing threats to the values of the natural environment. In turn, from an economic point of view, the key issue is the optimisation and efficiency of the use of resources in the management and development process. Another significant problem is the growing interregional and intraregional disproportions in the level of socioeconomic development and quality of life of residents, which generally leads to migration of people from less developed regions and local communities, and consequently weakens the possibility of their further functioning (Błachut, Cierpiał-Wolan, Czudec, Kata, 2018).

Socioeconomic development, understood as the scale, pace, and direction of changes in regional and local communities leading to better conditions and quality of life, as well as the resulting spatial structure and forms of space development, are spatially diverse and are the result of many conditions. They can be divided into the following groups regarding conditions: historical, related to the location in geographical space and economic structures, the natural environment and the quality of the human environment, the level of infrastructure development (social, technical, economic, institutional), the activity and effectiveness of local government activities, and also the entrepreneurship and innovation of residents. From a different perspective, we can also mention site conditions, environmental conditions, conditions resulting from space development, and conditions related to the quality of the regional or local community. The literature on the subject emphasises the key importance of sustainable development of local government units (including counties and communes), because it leads directly to improvement of the functioning of the economy and society, as well as the condition and quality of the natural environment (Heffner, 2007; 2011a, 2011b; Dziekański, 2018; Miłek, 2018; Grzebyk, Miś, Stec, Zając, 2019; Józefowicz, Smolińska, 2019; Utzig, Raczkowska, Mikuła, 2023).

Local development is a multidimensional concept, but it is usually perceived as a process of positive quantitative and qualitative changes taking place in the social and economic sphere of a given local government unit (i.e., poviat or commune), taking into account the needs, preferences, and hierarchy of values specific to its inhabitants (Sztando, 2012; Król, 2015; Jóźwiakowski, 2016).

Local development can be considered on many levels, which is why it stands out (Balcerek-Kosiarz, 2018):

- ✓ local development that concerns a given area, i.e. changes in the territorial system;
- ✓ local development, which focusses on the needs of the local government community living in a given area;

- ✓ local development, which is a process, i.e., ongoing and therefore not a one-time action;
- ✓ local development, which is an expression of the activity of entities, institutions, and organisations.

The main goal of local development should be to guarantee the inhabitants of a given local government unit (i.e., poviat or commune) the possibly lasting improvement in their living conditions and quality. This can occur primarily by providing them with: work (income), conditions of material existence (food, housing, living in an environment that is not harmful to health), a positive environment for spiritual development (opportunity for education, recreation, participation in culture and entertainment, access to information, the possibility of travelling and contact with the wider environment), as well as the basic need for security and prospects for the future (sense of stability) and development opportunities for future generations (Król, 2015).

A characteristic feature of local development is the relatively low mobility of the main development factors, which include: the condition of infrastructure, qualifications of the labor force, social structure and branch structure of the economy, as well as general and technical knowledge of the local community. Therefore, the goal of local development policy should be the best possible use of these resources and factors (Król, 2015; Jóźwiakowski, 2016).

Effective implementation of local development policy depends on many factors, including primarily: understanding the essence and meaning of local development, willingness to act in this area, knowledge and ingenuity of the entities of this policy and the local economy, resources enabling development, unmet social needs that this development stimulate and direct, as well as on collecting appropriate financial resources, gathering people around the idea of local development and creating the right social climate, as well as on the effectiveness of the existing organisational structures of this development. However, the basic structure initiating and organising the local development process will always be the local government (district, commune), in relation to which the following conditions for the effectiveness of development policy are distinguished: pro-development activity, entrepreneurship, openness to innovation, new ideas and cooperation, inducing a collective process learning, readiness to build partnerships and create social capital (Guzal-Dec, 2015; Parysek, 2015; Zwolińska-Ligaj, 2019).

Local development factors can be divided into four basic groups, i.e., economic, social, technical and technological, and ecological. In the group of economic factors, the most important variables are: the size and the related functioning of the local market for goods and services, the situation on the local labour market, the amount and variability of income of the population, enterprises, and local government bodies. The rank and quality of local marketing and the level of management by local authorities should also be taken into account. The local economic situation is also influenced by external factors, including the country's macroeconomic situation. Some of the most important social factors include demographic changes and the pace and nature of urbanisation processes. The development and improvement

of social infrastructure, changes in the level and lifestyle of residents, the level of education, and the activity and participation of the authorities and the local community also play an important role. Technical and technological factors include: the quantity and quality of fixed capital and changes in its structure, development of research and development activities, the level of cooperation between the science and industry sectors, production diversification, and the development and improvement of technical infrastructure. However, the ecological factors of local development include access to natural resources, rationalisation of management of natural environment resources, implementation of the so-called "clean" technologies, stimulating the production of healthy food, improving the ecological awareness and culture of society and implementing modern environmental protection instruments. It should be added that the above factors usually influence development processes in a cumulative manner, making up a bundle of determinants of local development. There is often a coupling between individual factors. The issue of local development should therefore be considered comprehensively, bearing in mind that many processes have a cause-and-effect nature. Causes and effects are interconnected and connect to all mentioned aspects of development. They can constitute factors of local development, but, on the other hand, they can also effectively inhibit this development (Kiczek, Pompa-Roborzyński, 2013; Ziółkowski, 2015; Jóźwiakowski, 2016; Balcerek-Kosiarz, 2018).

Moreover, in the case of local development, attention should be paid to its internal (endogenous), external (exogenous) factors, and various types of centrifugal forces. In the case of endogenous factors, the basis for local development is the existing resources of basic production factors (i.e., human, property, raw materials, etc.), but their development, quality, availability, and efficiency of use as well as adequacy to the generally accepted and accepted development strategy are very important. Exogenous factors, in turn, include the state's economic policy and its entire environment, as well as spatial policy. Also of great importance in this respect are: state-wide social policy, state-wide basis for shaping the level and quality of social life, the country's situation in the international system, and the nature of trade with other countries (import and export policy). In the modern economy, despite the increasing importance of exogenous factors of local development, mainly related to national and European Union policies and the dynamic development of the international flow of human and financial capital, special attention is paid to endogenous factors. They constitute very important conditions for local development and the functioning of local government, because they have a significant impact on the scale, directions, and dynamics of socioeconomic development and also constitute the primary (somehow natural) conditions in which local government functions and conducts its own development policy (Zakrzewska-Półtorak, 2011; Król, 2015; Jóźwiakowski, 2016; Józefowicz, Smolińska, 2019; Grzebyk, Sołtysiak, Stec, Zając, 2020).

2. Research aim, empirical material, and research methods

The aim of the article is to identify and evaluate selected endogenous conditions of local development in land counties in Poland, depending on changes in the number of their inhabitants.

The article presents a research hypothesis that assumes that the conditions of local development vary between land counties in Poland, depending on changes in the number of their inhabitants, with the best conditions in the group of counties characterised by an increase in this number.

The empirical material of the article concerns all land districts in Poland. The numerical data come from the Local Data Bank of the Central Statistical Office in Warsaw and concern 2023. The collected and organised empirical material was developed in descriptive, tabular, and graphic form, using the method of comparative analysis.

To identify and assess the conditions of local development in rural districts in Poland, the following diagnostic features illustrating them in 2023 were analysed: population density (population per 1 km^2), percentage of the working-age population, nonworking-age population per 100 working-age people, natural increase per 1,000 population, net migration for permanent residence per 1000 population, percentage of population using water, sewage and gas networks, average monthly gross salary (PLN), total income of poviat budgets per capita (PLN), own income of poviat budgets per capita (PLN), the share of own income in the total income of poviat budgets (%), total expenditure of poviat budgets per capita (PLN), investment expenditure of poviat budgets per capita (PLN) and share of investment expenditure in total expenditure of poviat budgets (%).

When analysing the diversity of local development conditions in land countries in Poland, it was assumed that the leading feature in this respect is changes in the number of inhabitants, i.e. a clear increase, stagnation or a clear decrease in this number. For the purposes of the research, the article divided all land counties in Poland into three groups, i.e.:

- I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023 (these are units in which the population dynamics in the years 1995-2023, with 1995 = 100, is above 110.0);
- II – land countries (poviats) with stagnation in the number of inhabitants in the years 1995-2023 (these are units in which the population dynamics in the years 1995-2023, with 1995 = 100, ranges from 90.0 to 110.0);
- III – land countries (poviats) with a decrease in the number of inhabitants in the years 1995-2023 (these are units in which the population dynamics in the years 1995-2023, with 1995 = 100, is below 90.0).

Moreover, the article provides a point assessment of the analysed diagnostic features illustrating the conditions of local development in separate groups of land counties in Poland depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country in 2023. Individual diagnostic characteristics were compared with the average for land counties in Poland, which was taken as 100 points, and their advantage or underweight was evaluated accordingly in all counties covered by the study. Then, all points were summarised and the average was calculated (graphs 1-4). It should be emphasised that this is a new approach to the research problem discussed in the article.

3. Results

The data contained in Table 1 show that the land counties in Poland are diverse in terms of the characteristics analysed illustrating the demographic conditions of local development, and this applies in particular to population density and the net migration rate for permanent residence per 1000 population. It should be added that in the case of all selected characteristics that characterise demographic conditions, the group of rural counties with an increase in the number of inhabitants in the years 1995-2023 is the most favourable. However, the worst situation in this regard occurs in the group of land counties with a decrease in the number of inhabitants in the years 1995-2023.

Table 1.
Selected features characterising demographic conditions in land countries in Poland in 2023

Specification	Land counties (poviats)			
	Total	According to changes in the number of inhabitants in the years 1995-2023		
		I	II	III
Population density - population per 1 km^2	99,2	183,5	102,4	72,1
Percentage of the population of working age	58,4	59,2	58,6	57,9
Population of non-working age per 100 people of working age	71,3	69,0	70,7	72,7
Natural increase per 1000 population	-4,0	-0,5	-3,4	-5,8
Balance of migration for permanent residence per 1000 population	-0,5	+8,1	-0,7	-2,7

Explanations for the table: I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023; II – land counties with stagnation in the number of inhabitants in the years 1995-2023; III – land counties with a decrease in the number of inhabitants in the years 1995-2023.

Source: Central Statistical Office in Warsaw.

In land countries in Poland, the most developed infrastructure element is the water supply network, followed by the sewage network, and the least developed is the gas network. However, there are differences between land counties in terms of the access of their inhabitants to the sewage and gas networks. Namely, the best situation in this respect occurs in the group of rural poviats with an increase in the number of inhabitants in the years 1995-2023. However, the group of rural poviats with a decrease in the number of inhabitants in the years 1995-2023 has the cheapest access to these infrastructure elements. In turn, in the case of population access to the water supply network, there are no major differences in this respect between separate groups of countries in Poland, depending on changes in the number of their inhabitants in the years 1995-2023 (Table 2).

Table 2.
Selected features characterising infrastructure conditions in land contries in Poland in 2023

Specification	Land counties			
	Total	According to changes in the number of inhabitants in the years 1995-2023		
		I	II	III
Percentage of the population using the water supply network	90,5	88,0	91,1	90,5
Percentage of the population using the sewage network	60,4	65,1	62,9	55,8
Percentage of the population using the gas network	40,0	58,5	41,9	32,5

Explanations for the table: I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023; II – land counties with stagnation in the number of inhabitants in the years 1995-2023; III – land counties with a decrease in the number of inhabitants in the years 1995-2023.

Source: Central Statistical Office in Warsaw.

The data in Table 3 indicate that the land districts in Poland are diverse in terms of the characteristics analysed features illustrating the economic and financial conditions of local development. The average value of the average monthly gross salary is the highest in the group of land counties with an increase in the number of inhabitants in the years 1995-2023. The situation is similar in the case of the average value of own revenues of poviat budgets per capita, as well as the share of own revenues in the total revenues of poviat budgets. In turn, the average value of total income of poviat budgets per capita is the highest in the group of land poviats with a decrease in the number of inhabitants in the years 1995-2023.

The land counties in Poland are also diverse in terms of the expenditure of their budgets. Namely, the average value of total expenditure and investment expenditure of poviat budgets per capita is the highest in the group of land poviats with a decrease in the number of inhabitants in the years 1995-2023. However, these values are the lowest in the group of land counties with an increase in the number of inhabitants in the years 1995-2023. In turn, the share of investment expenditure in the total expenditure of land poviat budgets is similar in all their groups, depending on changes in the number of inhabitants in the years 1995-2023 (Table 3).

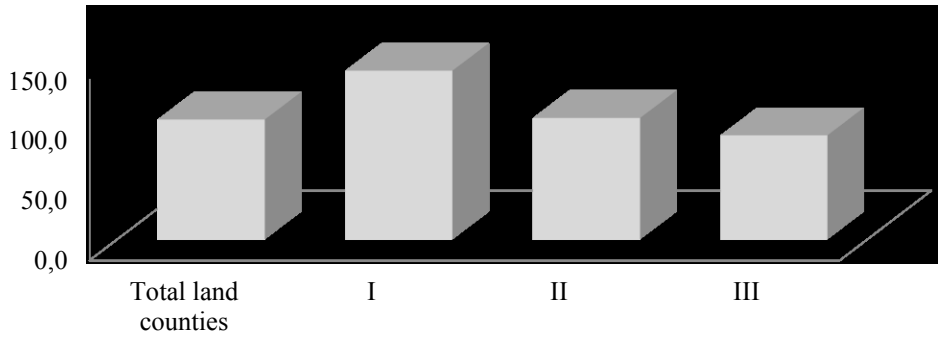
Table 3.
Selected Characteristics of the economic and financial conditions in land countries of Poland in 2023

Specification	Land counties			
	Total	According to changes in the number of inhabitants in the years 1995-2023		
		I	II	III
Average monthly gross salary in PLN	6442,3	6759,7	6391,2	6419,6
Total revenues of poviat budgets per capita in PLN	1935,1	1461,4	1890,8	2120,7
Own revenues of poviat budgets per capita in PLN	601,6	617,5	600,6	598,5
Share of own revenues in total revenues of poviat budgets in %	32,0	43,4	31,9	28,9
Total expenditure of poviat budgets per capita in PLN	2001,5	1536,3	1952,0	2191,3
Investment expenditure of poviat budgets per capita in PLN	492,1	373,5	469,2	553,6
Share of investment expenditure in total expenditure of poviat budgets in %	23,6	24,2	23,4	23,6

Explanations for the table: I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023; II – land counties with stagnation in the number of inhabitants in the years 1995-2023; III – land counties with a decrease in the number of inhabitants in the years 1995-2023.

Source: Central Statistical Office in Warsaw.

Figure 1 presents the results of the point assessment of the selected demographic conditions of local development in separate groups of land counties in Poland depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country for 2023. It should be noted that the land counties of Poland are very diverse in this regard. Namely, the best demographic conditions for local development are found in the group of land counties characterised by an increase in the number of inhabitants in the years 1995-2023. In turn, they are the worst in the group of land counties characterised by a decrease in the number of inhabitants in the years 1995-2023. However, in the group of land counties with stagnation in the number of inhabitants in the years 1995-2023, they are more similar to the average for all land counties in Poland.



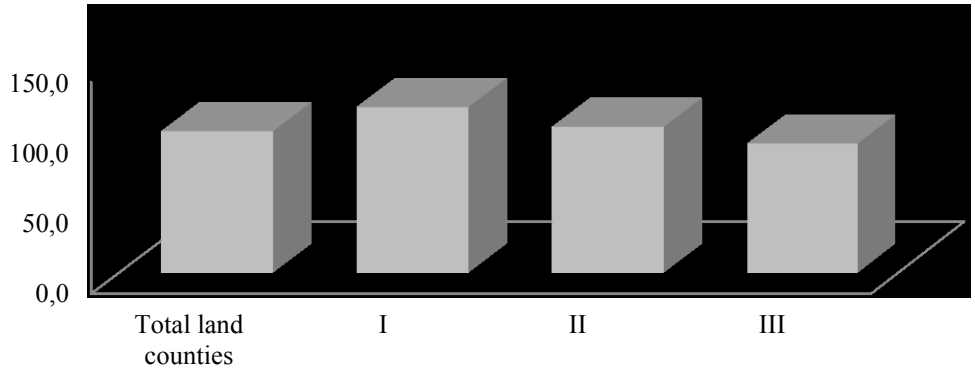
Explanations for the figure: I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023; II – land counties with stagnation in the number of inhabitants in the years 1995-2023; III – land counties with a decrease in the number of inhabitants in the years 1995-2023.

Figure 1. Point assessment of selected demographic conditions of local development, in separate groups of land counties in Poland, depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country for 2023 (counties in Poland = 100.0 points)

Source: Own study.

Figure 2 presents the results of the point assessment of selected infrastructural conditions of local development in separate groups of land counties in Poland depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country for 2023. On this basis, it should be stated that rural districts in Poland are diverse in this respect, and, as previously noted, this is mainly due to the different accessibility of their inhabitants to the sewage and gas networks. Therefore, the best infrastructure conditions for local development are characterised by the group of land counties with an increase in the number of inhabitants in the years 1995-2023. In turn, the worst infrastructural conditions for local development occur in the group of rural poviats with a decrease in the number of inhabitants in the years 1995-2023. However, in the group of land counties with stagnation in the number of inhabitants in the years 1995-2023, the discussed infrastructure conditions of local development are most similar to the average for all land counties throughout the country.

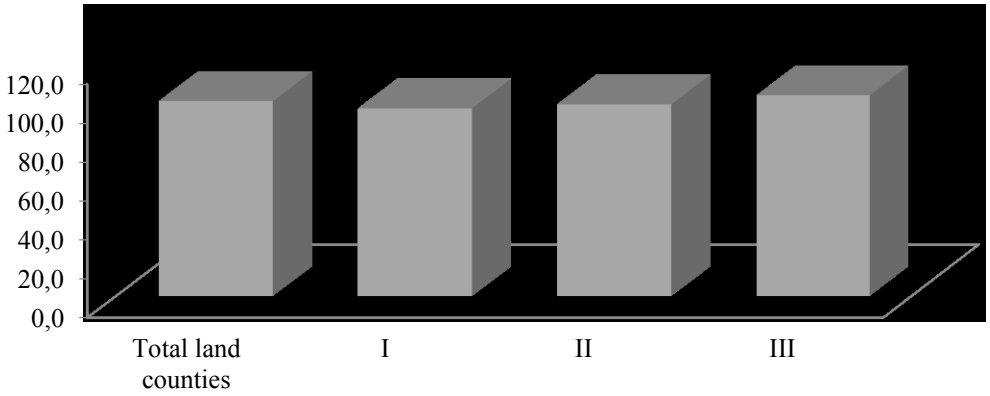
Figure 3 shows the results of the point assessment on selected economic and financial conditions of local development in separate groups of land counties in Poland based on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country for 2023. Therefore, it can be noted that the separated groups of land counties are not significantly different in this respect. Because in all of them, the economic and financial conditions of local development are similar to the average for all land counties throughout the country, but the best economic and financial situation occurs in the group of land counties with a decrease in the number of inhabitants in the years 1995-2023.



Explanations for the figure: I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023; II – land counties with stagnation in the number of inhabitants in the years 1995-2023; III – land counties with a decrease in the number of inhabitants in the years 1995-2023.

Figure 2. Point assessment of selected infrastructure conditions of local development, in separate groups of land counties in Poland, based on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country for 2023 (counties in Poland = 100.0 points)

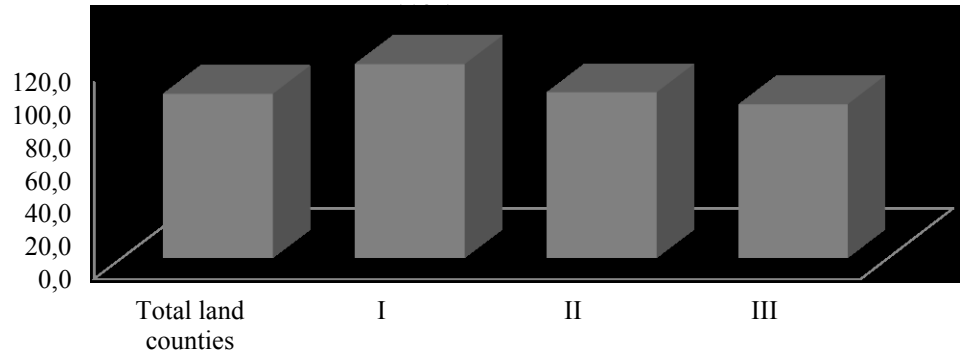
Source: Own study.



Explanations for the figure: I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023; II – land counties with stagnation in the number of inhabitants in the years 1995-2023; III – land counties with a decrease in the number of inhabitants in the years 1995-2023.

Figure 3. Point assessment of selected economic and financial conditions of local development, in separate groups of land counties in Poland, depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country for 2023 (counties in Poland = 100.0 points).

Source: Own study.



Explanations for the figure: I – land counties (poviats) with an increase in the number of inhabitants in the years 1995-2023; II – land counties with stagnation in the number of inhabitants in the years 1995-2023; III – land counties with a decrease in the number of inhabitants in the years 1995-2023.

Figure 4. Scoring of all selected local development conditions (ie, demographic, infrastructural and economic and financial conditions together), in separate groups of land counties in Poland, depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country 2023 (counties in Poland = 100.0 points).

Source: Own study.

Figure 4 shows the results of the point assessment regarding all selected conditions of local development (i.e. demographic, infrastructural, and economic and financial conditions together), in separate groups of land counties in Poland depending on changes in the number of their inhabitants in the years 1995-2023, against the background total land districts in the country for 2023. On its basis, it must be concluded that the local government units in Poland are diverse in this respect. Namely, the group of land counties with an increase in the number of inhabitants in the years 1995-2023 clearly has the best conditions for local development. In turn, they are the worst in the group of land counties characterised by a decrease in the

number of inhabitants in the years 1995-2023. However, in the group of land counties with stagnation in the number of inhabitants in the years 1995-2023, the analysed local development conditions are very similar to the average for all land counties in Poland.

This allows us to confirm the research hypothesis presented in the article, which assumes that the conditions of local development vary between land counties in Poland, depending on changes in the number of their inhabitants, with the best conditions being in the group of counties characterised by an increase in this number.

4. Summary and conclusions

The conditions of local development in poviat local government units in Poland are a very important, interdisciplinary, extensive, and broad issue, constituting, among others, an important research issue for both economic theory and economic practice.

The analysis of the collected statistical data carried out in the article shows that:

- ✓ The demographic and infrastructure conditions of local development vary between districts in Poland, depending on changes in the number of their inhabitants in the years 1995-2023. They are clearly the best in the group of land counties with an increase in the number of inhabitants, while the worst are in the group of land counties with a decrease in this number.
- ✓ The economic and financial conditions of local development are similar in all separate groups of land counties in Poland, depending on changes in the number of their inhabitants in the years 1995-2023, and similar to the average for all land counties throughout the country.
- ✓ In turn, a point assessment of all analysed conditions of local development (i.e. demographic, infrastructural and economic and financial together), in separate groups of land counties in Poland, depending on changes in the number of their inhabitants in the years 1995-2023, against the background of all land counties in the country, showed that the studied groups of local government units are diversified in this respect - in favor of the group of counties with an increase in the number of mixed inhabitants. This allows us to confirm the research hypothesis, which assumes that the conditions of local development vary between land counties in Poland, depending on changes in the number of their inhabitants, with the best conditions in the group of counties characterised by an increase in this number.

The results of the analysis of the collected statistical data presented in the article provide important and up-to-date knowledge that may be useful for local government officials responsible for the conditions, possibilities, and directions of local socio-economic development of poviat local government units in Poland, as well as for other decision-makers involved in the implementation of local development policy.

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SUCCESS CRITERIA AND FACTORS OF AGILE-MANAGED IT PROJECTS

Bartosz STEC

Wrocław Tech; Bartosz.stec@pwr.edu.pl, ORCID: 0009-0004-0760-8227

Purpose: This study examines Agile practices as factors in the success of Agile-managed IT projects. These factors contribute to project success based on sector-specific success criteria. The result of the article is developed and validated through an empirical research model that connects Agile practices with these criteria.
Design/methodology/approach: A qualitative approach was used - in-depth interviews with Agile practitioners engaged in IT projects. Respondents assessed the relationships between Agile success factors (practices, tools, and artifacts) and the criteria that define project success. To ensure practical relevance, experts reviewed the model to verify its applicability and utility.
Findings: The study identified several Agile practices as significant contributors to IT project success, particularly in planning, product backlog management, and consistent software delivery. However, daily meetings were found to contribute only marginally to some success criteria. The model suggests that certain Agile practices may be less aligned with traditional success criteria, such as meeting budget and time constraints.
Research limitations/implications: The study's qualitative design may limit its generalizability, potentially missing variation in Agile practices across different types of projects. Future research could adopt, in addition, a quantitative approach, allowing for more specific insights across varied project types. Additionally, further study could focus on the role of success criteria in relation to overall project outcomes.
Practical implications: The findings offer guidance for managers to emphasize specific practices that improve resource planning and execution based on their team's success criteria. Agile teams can use the model to assess the value of their practices in meeting project goals, allowing for a more targeted approach to optimizing Agile processes.
Originality/value: This study presents an extensive model that links a wide range of Agile practices directly to project success criteria, providing a practical framework for Agile teams to evaluate and refine their work. The research is valuable for project managers, Agile teams, and organizations looking to enhance their Agile strategies for better project results.
Keywords: Agile success factors, IT project success criteria, IT project success.
Category of the paper: Research paper.

1. Introduction

Project management is a crucial aspect of modern, growing organizations, providing structured approaches to planning, implementing, and controlling activities aimed at achieving project success. Traditional project management methods follow a sequential process, beginning with the identification of requirements, followed by detailed planning, and continuous progress monitoring (Project Management Institute, 2008). While these methods are effective in stable environments, they struggle to address the challenges of today's rapidly changing business landscape, where customer needs and technological innovations evolve at unprecedented speeds.

To respond to these challenges, the Agile Manifesto was introduced at the beginning of the 21st century, forming the foundation for various Agile project management methodologies. Frameworks such as Scrum, Kanban, and Extreme Programming are grounded in Agile principles, emphasizing iterative and incremental approaches to project execution (Hohl et al., 2018). These methodologies aim to enhance project outcomes by fostering adaptability, increasing responsiveness to change, and improving alignment with customer and market needs. Practices derived from these approaches can be collectively referred to as "project success factors", as they are specific elements, conditions, and variables that, when effectively implemented, improve the likelihood of project success (Ika, 2009).

The challenge in the current business landscape lies in understanding project success from multiple perspectives and these diverse factors that influence it. In 2008, the last time there was extensive research on the relationship between Agile success factors and IT project success (Chow, Cao, 2008). In this work, the authors adopted the success factors that were important at that time, and the criteria were general statements based on the management triangle. Over the last 20 years, this importance of factors has changed, because the approach itself has been gradually adapting to market requirements. The same goes for the success criteria. Success is now multi-dimensional. Studies such as this done by Kerzner (Kerzner, 2017) emphasize that project success is defined across various perspectives, including budget, schedule, quality, and stakeholder satisfaction, many at the same time. The research initiated by Chow and Cao was continued. However, they did not evaluate the current state of the criteria or factors themselves but rather selected parts of them and tried to deepen them (Stankovic et al., 2018). However, there is no actual research in the available literature on the relationship between Agile success factors and the set of currently used success criteria. Specifically, there is no comprehensive model that maps a wide range of Agile practices to an extended set of project success criteria, divided into clear categories. This lack of a detailed framework limits the ability of managers to align practices with specific outcomes effectively.

This paper aims to address this gap by linking selected Agile success factors with project success criteria specific to the IT industry. The article seeks to bridge this gap through a structured, three-phase research process. The first phase involved an extensive literature review to identify key Agile practices and success criteria. This review resulted in a focus on 18 Agile success factors and 10 project success criteria - those most frequently mentioned in prior studies over the years. The term "Agile success factors" is used interchangeably with "Agile practices" throughout this work and includes practices, activities, and artifacts derived from Agile methodologies. By concentrating on widely recognized factors, the research ensures a balance between depth and breadth, avoiding the narrower focus of some previous studies that limit practical insights. The second of part of the research consisted of qualitative interviews with Agile practitioners, who evaluated the relationships between the identified success factors and criteria. These insights were synthesized into a detailed mapping that illustrates how Agile practices influence different success metrics (Fig. 1). Finally, the third phase involved validation through expert interviews. Experienced professionals assessed the proposed model, confirming its relevance to real-world project management and suggesting refinements to improve its practical applicability.

The findings reveal that Agile practices are more effective in supporting certain success criteria, such as team satisfaction and functional quality than others, like meeting budget and schedule compliance. This nuanced understanding addresses the identified research gap and provides a practical model for Agile teams and project managers. By offering a detailed framework that links Agile practices to specific project success criteria, this study contributes both to academic knowledge and to practical advancements in IT project management.

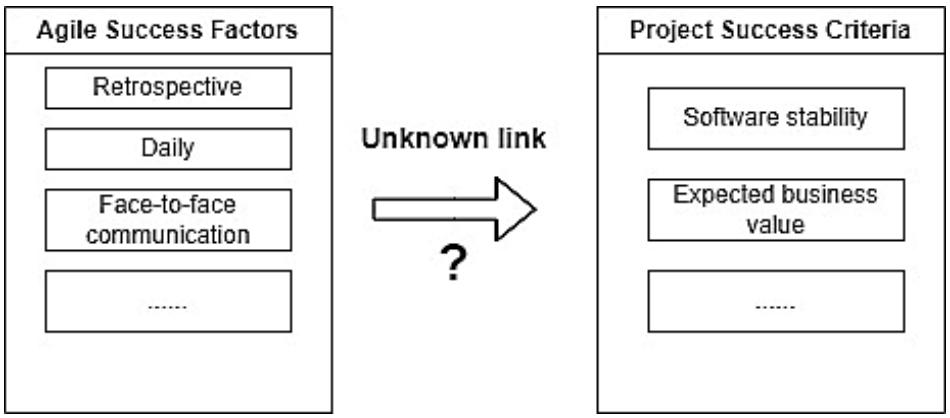


Figure 1. Model concept.

Source: Own elaboration.

2. Method

This paper's research was conducted in three stages. The first stage involved identifying Agile practices, and project success criteria by literature review. Then, part two, examines the links between these groups with Agile practitioners – resulting in creating a model. The third stage centered on an initial validation of the model by IT industry experts. This research structure and methodology were chosen to provide a well-rounded view of how Agile practices influence the success of IT projects (Fig. 2).

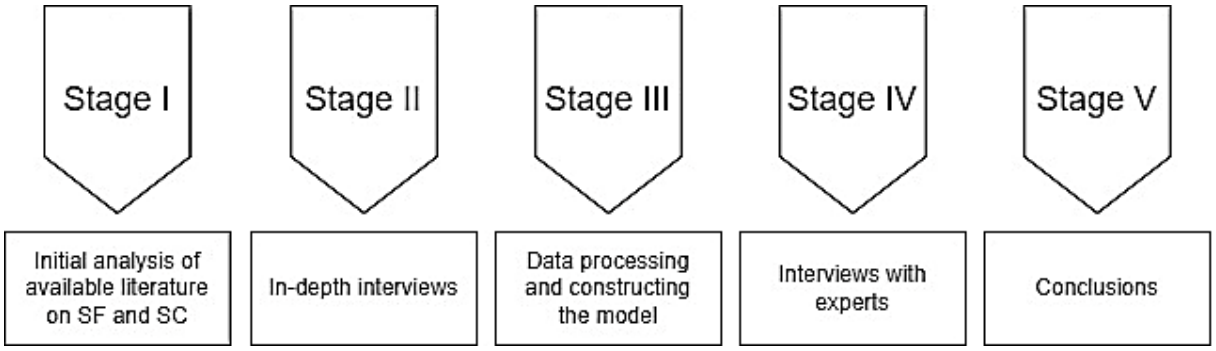


Figure 2. Research general plan.

Source: Own elaboration.

2.1. Systematic literature review – stage I

In this case, the literature review concentrates on providing a general overview of success factors within Agile work methodology and success criteria specific to Information Technology (IT) projects. The goal is to gather sources that discuss these two areas, critically evaluating their relevance to addressing the research question, which is formulated as follows: "How, do specific activities, artifacts, and practices from the Agile work methodology (success factors) impact IT projects' specific success criteria?"

The sources for this review were drawn from two major global databases, Web of Science and Scopus. The author organized the review in two rounds, each dedicated to one of these aspects. This approach resulted in two distinct literature pools - one for success factors and one for success criteria. To ensure a comprehensive literature review, the author applied an advanced search strategy, specifying multiple search criteria to accurately target relevant sources. Each search round and the associated search prompts are outlined below.

- **Agile success factors** => (((ALL=(agile)) AND ALL=(success factor*)) AND ALL=(IT) AND ALL=(project*))
- **IT project success criteria (Non-Agile)** => ((ALL=(success criteria*)) AND ALL=(project*) AND ALL=(IT))

The initial literature collection comprised nearly 400 items. At this stage, the author established inclusion and exclusion criteria to refine the set, focusing on items that directly relate to the research question. These criteria were categorized as "general" and "specific" to the two research areas. The author followed the PRISMA guidelines (Mazur et al., 2018) to ensure a structured approach, as illustrated in Fig. 3. Additionally, a "backward analysis" was conducted, which involved examining the bibliographies of accessible publications to identify foundational sources referenced by other authors (Jalali, Wohlin, 2012). This process led to the identification of four additional sources addressing success factors and success criteria in IT projects. The literature review resulted in tables summarizing the most commonly cited Agile team practices, along with the criteria frequently used to assess the projects' success they execute.

- **General criteria**

Admission criteria – all had to be met (failure to meet one eliminates from further analysis)

a) The research published after 2000 (the Agile methodology was initiated the year after).
b) The research published in English.
c) Fully available research (full text).
d) The research focused on IT projects or teams.

- **Criteria for each research topic**

Acceptance criteria – Agile success factors - meeting at least two qualifies for analysis

a) The research concerns success factors of IT projects or teams.
b) The research focuses on best practices of Agile teams in IT.
c) The research concerns Agile team performance.
d) The research concerns conditions in IT projects that affect teams operating in Agile.

- **Rejection criteria – Agile success factors –** meeting any of them eliminates from analysis
  a) The research does not concern the Agile work methodology in any way.
  b) The research focuses only on Agile trends.
  c) The research concerns the implementation or scaling of Agile in companies and teams.
  d) The research concerns Agile-hybrid methodologies.
- **Acceptance criteria – success criteria in IT projects**
  a) The research concerns the success criteria of IT projects.
- **Rejection criteria – success criteria in IT projects**
  a) The research concerns the impact of various company management methods and the functioning of stakeholders on the success criteria.
  b) The research focuses on Customer Success Managers.

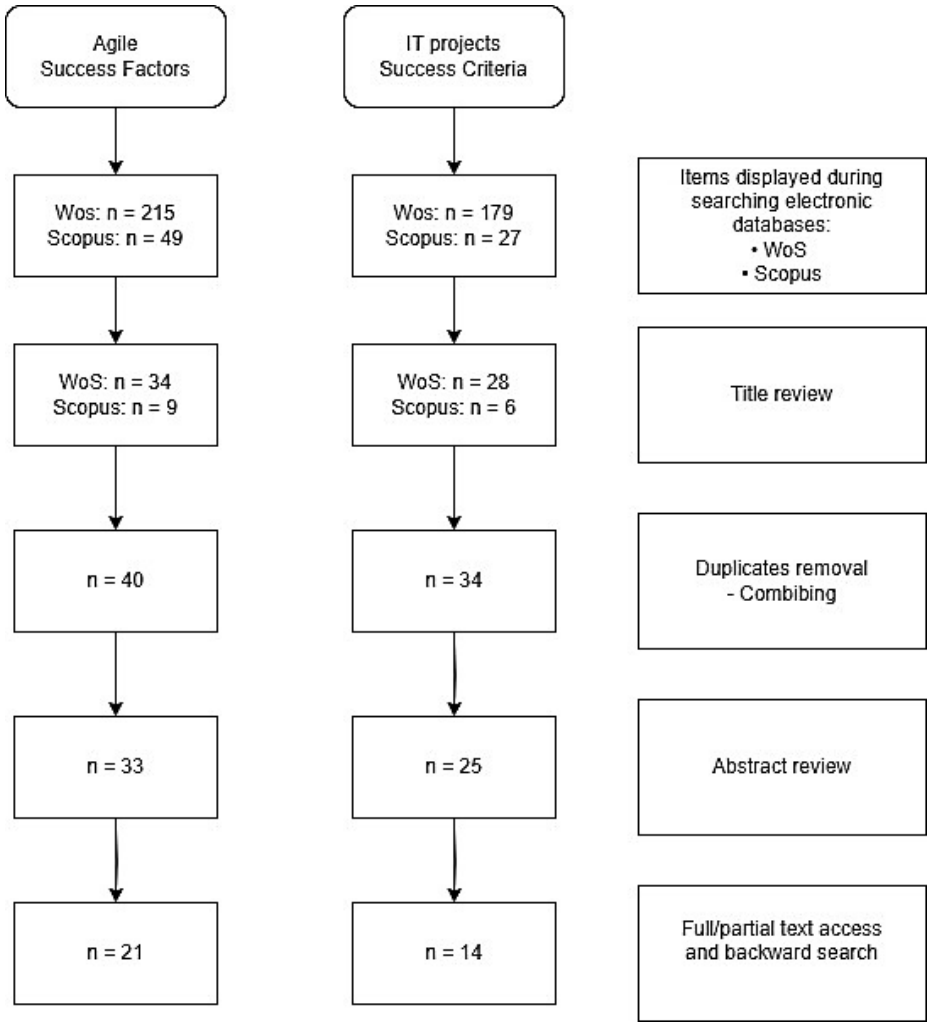


Figure 3. PRISMA standard used in literature review.

Source: Own elaboration.

The preparation process for both factors and criteria involved creating a frequency table (Table 3, Table 4 - Appendix) showing how often each Agile success factor and criterion was cited in the literature. To ensure relevance, the author implemented a multi-step selection process for Agile success factors and project success criteria:

1) **Literature Frequency**: Only factors referenced at least five times in the literature were included, as this frequency indicated their potential importance. Criteria with at least six mentions were selected.
2) **Agile-Specific Relevance**: Factors directly linked to Agile methodologies were prioritized over general business factors. For instance, while "high skills of the project team" is a widely recognized success factor, it is not exclusive to Agile. In contrast, "the team has all competencies to implement the project," which aligns with Scrum's concept of a multifunctional team, was deemed more Agile-specific.
3) **Reformulation for Precision**: Selected factors were refined to better reflect specific Agile practices or artifacts. Where appropriate, broader factors were broken down into more detailed components to facilitate a focused analysis of critical success factors in Agile IT projects. Criteria were refined similarly.

2.2. Empirical research – stage II

As outlined in section 2.1, the author's research focuses on the success of Agile projects. The initial phase of the empirical research aims to gather the data necessary to develop a model illustrating the relationships between success factors and criteria (Stage III). The primary objective of this empirical research can be stated as follows: "Investigating what impact the practices and tools used by Agile teams selected by the author have on the success criteria of the IT projects they implement. Do they help or hinder their fulfillment?"

Later it will be shown that 18 factors and 10 criteria were selected from the literature (Section 3.1), each to be rated by its degree of influence. The author proposed a scale ranging from -1 to 1, step 1/2. Value "-1" indicates that the success factor hinders meeting the success criterion (if the criterion is adopted for project evaluation), "0" signifies no impact or a balanced effect of positive and negative influences, and "1" reflects a clear positive impact, where the success factor supports meeting the criterion.

2.2.1. Methodology

Initially, quantitative approaches - particularly surveys - were considered for their efficiency and scalability in data collection (Babbie, 1990; Fowler, 2009). However, given the task of evaluating 180 (18 potential success factors and 10 success criteria) specific relationships between Agile success factors and criteria, there was a high risk of respondent fatigue. Such fatigue could lead to superficial responses or survey abandonment (Bryman, 2016), thereby compromising the reliability of the data - a risk that would undermine the objective of producing meaningful insights. In contrast, qualitative research offers a way to gather context-rich, nuanced insights directly from participants' experiences, aligning well with the objectives of this study. Agile project outcomes are often highly contextual, and shaped by factors such as team dynamics, organizational culture, and individual expertise. Qualitative methods are ideal for exploring these dimensions, as they allow participants to articulate how and why specific practices impact project success, beyond merely indicating agreement or frequency on predefined scales (Creswell, 2007; Marshall, 2006). Ultimately, qualitative interviews emerged as the optimal approach, enabling the collection of complex, context-specific insights necessary to understand Agile project success. This approach's flexibility, coupled with its capacity to capture in-depth participant experiences, makes it particularly suited to this study's goals.

The interview format was also carefully chosen. Semi-structured individual interviews were selected over group formats. Given that perceptions of practice impact can vary widely within Agile teams, group settings could lead to response conformity or dominant voices influencing the discussion, potentially skewing results (Butt et al., 2023). Semi-structured interviews, combining open-ended and focused questions, offer a balance of flexibility and consistency. This format allowed for an in-depth examination of specific factor-criteria relationships and captured individual perspectives, while also providing structure on critical areas, such as assigning weights to practices and exploring role-specific project contexts (Rubin, 2011).

2.2.2. Tools

The study was conducted from February to March 2024, with interviews held both in person and online. Microsoft Excel played a critical role during the interviews, particularly in managing the intensive weighting task. Excel's functionality, including drop-down lists for selecting weights, automated calculations, and real-time summaries, significantly accelerated the process. Additionally, any comments related to respondents' assigned weights were immediately recorded as in-document notes. Figure 4 shows a sample sheet from the study, illustrating the process: weights were selected from a list, and comments were added as annotations (indicated by purple markers in the cells).

To ensure that interviews were efficient, consistent, and substantive, a structured script was developed. The script was organized into three parts. The first part covered introductory questions on participants' current employment, Agile experience, and professional profiles. The second section, the focal point of the interview, addressed success factors and criteria, focusing on assigning weights to each factor in relation to the criteria. This section was designed to occupy over 90% of the interview duration.

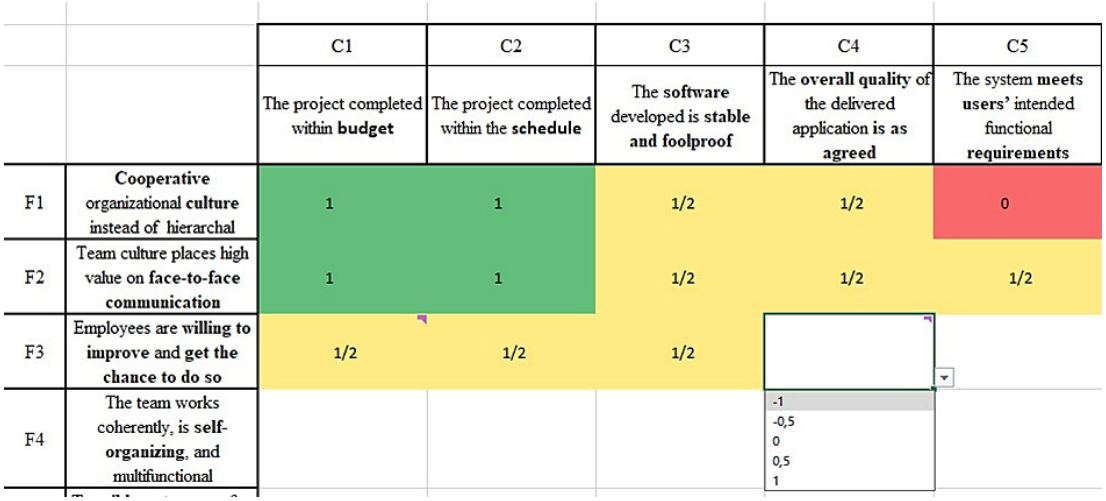


Figure 4. Assigning weights during the interview.

Source: Own elaboration.

2.3. Empirical research – stage IV

The first phase of the research focused on identifying connections between success criteria and success factors. In this chapter, the next research phase is described. This part was conducted to verify the alignment of these connections with the proposed model and to perform a preliminary validation of the findings.

2.3.1. Research aim and method

The model created with data from the first phase of empirical research was analyzed and evaluated by selected experts from the IT industry. This initial expert assessment provided a foundational verification for further model development and potential practical applications. The purpose of the expert validation was to examine how well the model's results aligned with

real-world business conditions. Three IT professionals with extensive Agile experience were chosen based on the following criteria:

1) **Professional Experience:** Each expert had a minimum of seven years in the IT industry, with at least five years specifically in Agile project work.
2) **Diversity of Roles:** Experts had experience across multiple roles, such as Developer, Scrum Master, Technical Leader, or similar.
3) **Reputation and Achievements:** Experts were recognized authorities in the field, with successful track records in implementing IT projects.

During individual meetings, the model and empirical findings were presented to the experts. Building on a prior review of research methods (Section 2.2.1), the author chose to conduct semi-structured interviews that combined open discussions with feedback on specific model elements. The discussions covered several key areas:

1) **Model Usability:** Experts assessed the technical structure, alignment of success factors with criteria, practical applications, and potential benefits of the model for Agile teams.
2) **Validity of Results:** Experts evaluated whether the model results reflected their experiences with Agile project teams and matched real-world development conditions.
3) **Improvement Suggestions:** Experts provided recommendations for refining the model to increase its practical utility and accuracy.

3. Results

The results of the conducted research are divided into 3 parts. The first part describes the results of the literature review, i.e. the list of success factors (Table 1) and success criteria (Table 2). The second part collects the results of empirical research with members of Agile teams, presented in the form of a table - called a model (Figure 5). The third and last part describes the results of interviews with experts on the proposed model (Section 3.3).

3.1. Literature review results – stage I

3.1.1. Success Factors

The final table of Agile success factors is provided below, representing the most impactful factors identified in the context of Agile methodologies and IT project success.

Table 1.
Final success factors table

ID	Success factors	
	Factor name	**The original name of the factor from the literature review – if it was changed**
F1	Cooperative organizational culture instead of hierarchal	-
F2	Team culture places high value on face-to-face communication.	-
F3	Employees are willing to improve and get the chance to do so.	-
F4	The team works coherently, is self-organizing, and multifunctional.	-
F5	Tangible outcomes after each iteration	-
F6	Culture of open feedback	-
F7	Usage of the "User Stories" tool	Following an Agile-oriented requirement management process
F8	Sprint plannings and creating sprints' backlogs	Following an Agile-oriented requirement management process
F9	Scrum master as a team facilitator	Following an Agile-oriented project management process, facilitated by Scrum Master
F10	Retrospectives	Following an Agile-oriented project management process, facilitated by Scrum Master
F11	Sprint Reviews and backlog refinements	Following an Agile-oriented project management process, facilitated by Scrum Master
F12	Strong communication focus with daily meetings	-
F13	Strong customer commitment and presence	-
F14	The right amount of documentation	-
F15	Regular delivery of software	-
F16	Delivering the most important features first	-
F17	Project nature being non-life-critical	-
F18	Small project team – up to 10 members	Projects with a small team

Data was gathered by author during literature review, the original table with the frequency of each factor can be found in the Appendix.

Source: Own elaboration.

3.1.2. Non-Agile, IT project success criteria

Table 2.
Final success criteria table

Item	Success criteria	
	Criterion name	**The original name of the criterion from the literature review – if it was changed**
C1	The project completed within budget	-
C2	The project completed within the schedule	-
C3	The software developed is stable and foolproof	The software developed is reliable
C4	The overall quality of the delivered application is as agreed	The overall quality of the delivered application is high (or, as agreed on)
C5	The system meets users' intended functional requirements	-
C6	Important initial requirements have been met	The project scope was met (gathered requirements)
C7	Product is profitable or brings the promised business value	Product brings benefits to the client (profitable) AND Project has added the promised business value

Cont. table 2.

C8	Users are satisfied with the system delivered	Users were satisfied with the system delivered (users' requirements)
C9	The project team is satisfied	-
C10	Customer is satisfied	Customer satisfaction

Data was gathered by author during literature review, the original table with frequency of each criterion can be found in Appendix.

Source: Own elaboration.

The criteria encompass four general areas of project success. The first three criteria cover the project management "iron triangle": time, budget, and scope/quality (Pollack et al., 2018). The fourth area addresses stakeholder satisfaction. Within this structure, budget and schedule are represented as single criteria. However, the scope/quality dimension is subdivided into multiple criteria (C3 to C7), reflecting Agile methodologies' emphasis on work scope and delivery, including quality, stability, and business value. The last three criteria relate to satisfaction - addressing team, client, and user feedback, with "satisfaction" focusing on both process feedback and the final project outcome.

3.1.3. Summary of literature review

The literature review shows that the author has thoroughly surveyed existing studies on success criteria and factors impacting Agile IT project success (as can be seen on the original list of all gathered factors and criteria in Appendix). This extensive review has provided a robust foundation, ensuring that the theoretical basis is solid for the subsequent research steps. The research question guiding this chapter was as follows: "How do specific activities, artifacts, and practices from the Agile work methodology (success factors) impact the final success of IT projects as defined by project success criteria?"

The literature review was divided into two segments to explore these elements. The first segment identified specific Agile activities, artifacts, and practices critical to IT project success, presented in Table 1. The second segment defined the general success criteria for IT projects, resulting in a set of criteria used to evaluate the impact of Agile practices on project success (see Table 2).

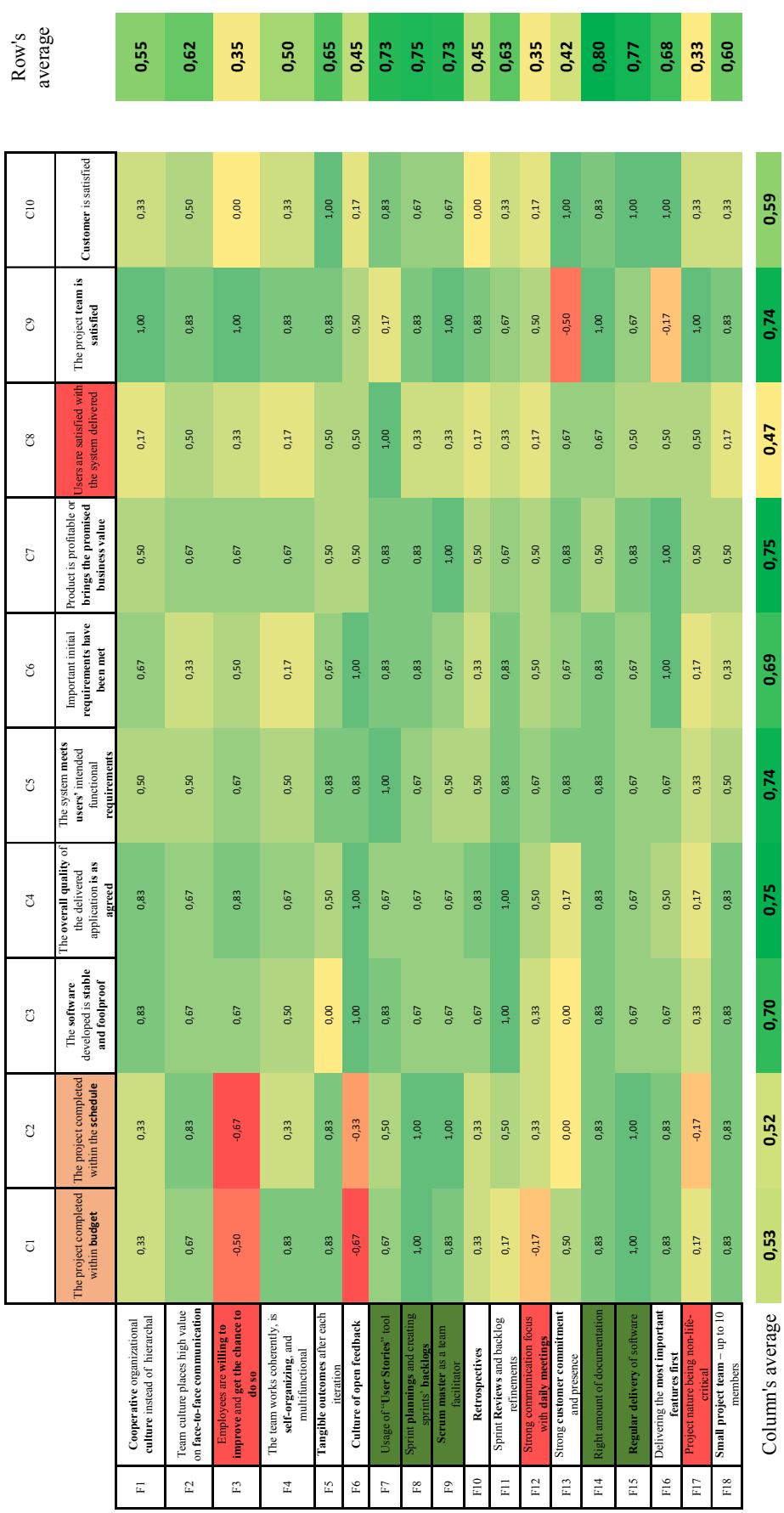
3.2. Empirical research results – stage II and III – creating the model

3.2.1. Model creation

Figure 5 presents a table linking success factors with success criteria. This table, developed from the literature, enabled participants to assign weights to the connections between factors and criteria, indicating whether a factor supports or hinders a particular criterion. Success factors are listed on the left side, while criteria are shown at the top. Each cell in the matrix holds a weight that represents the effect of a specific factor on one criterion. The "Rows' average" column on the right summarizes each factor's overall impact by averaging all the weights assigned across the criteria, while the "Columns' average" row at the bottom shows the average effectiveness of each criterion in the context of the model's practices. Although simplified, this method provides insight by assuming the use of either all practices or all criteria, offering general observations.

In presenting the results, the following terminology will be used: "weights" refer to individual numbers within each cell of the table, while "averages" denote the column and row averages described above. The color-coded scale in the table indicates the degree of support or hindrance each factor provides to each criterion:

- **Strong green**: The factor strongly supports the criterion.
- **Lighter green**: The factor supports the criterion to a moderate extent.
- **Yellow**: The factor does not support the criterion.
- **Orange**: The factor moderately interferes with the criterion.
- **Strong red**: The factor significantly interferes with the criterion.



		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Row's average
		The project completed within **budget**	The project completed within the **schedule**	The **software** developed is **stable and foolproof**	The **overall quality** of the delivered application **is as agreed**	The system **meets users'** intended functional **requirements**	Important initial **requirements have been met**	Product is profitable or **brings the promised business value**	Users are satisfied with the system delivered	The project **team is satisfied**	**Customer** is satisfied	
F1	**Cooperative** organizational **culture** instead of hierarchal	0,33	0,33	0,83	0,83	0,50	0,67	0,50	0,17	1,00	0,33	**0,55**
F2	Team culture places high value on **face-to-face communication**	0,67	0,83	0,67	0,67	0,50	0,33	0,67	0,50	0,83	0,50	**0,62**
F3	Employees are **willing to improve** and **get the chance to do so**	-0,50	-0,67	0,67	0,83	0,67	0,50	0,67	0,33	1,00	0,00	**0,35**
F4	The team works coherently, is **self-organizing**, and multifunctional	0,83	0,33	0,50	0,67	0,50	0,17	0,67	0,17	0,83	0,33	**0,50**
F5	**Tangible outcomes** after each iteration	0,83	0,83	0,00	0,50	0,83	0,67	0,50	0,50	0,83	1,00	**0,65**
F6	**Culture of open feedback**	-0,67	-0,33	1,00	1,00	0,83	1,00	0,50	0,50	0,50	0,17	**0,45**
F7	Usage of "**User Stories**" tool	0,67	0,50	0,83	0,67	1,00	0,83	0,83	1,00	0,17	0,83	**0,73**
F8	Sprint **plannings** and creating sprints' **backlogs**	1,00	1,00	0,67	0,67	0,67	0,83	0,83	0,33	0,83	0,67	**0,75**
F9	**Scrum master** as a team facilitator	0,83	1,00	0,67	0,67	0,50	0,67	1,00	0,33	1,00	0,67	**0,73**
F10	**Retrospectives**	0,33	0,33	0,67	0,83	0,50	0,33	0,50	0,17	0,83	0,00	**0,45**
F11	Sprint **Reviews** and backlog refinements	0,17	0,50	1,00	1,00	0,83	0,83	0,67	0,33	0,67	0,33	**0,63**
F12	Strong communication focus with **daily meetings**	-0,17	0,33	0,33	0,50	0,67	0,50	0,50	0,17	0,50	0,17	**0,35**
F13	Strong **customer commitment** and presence	0,50	0,00	0,00	0,17	0,83	0,67	0,83	0,67	-0,50	1,00	**0,42**
F14	Right amount of documentation	0,83	0,83	0,83	0,83	0,83	0,83	0,50	0,67	1,00	0,83	**0,80**
F15	**Regular delivery** of software	1,00	1,00	0,67	0,67	0,67	0,67	0,83	0,50	0,67	1,00	**0,77**
F16	Delivering the **most important features first**	0,83	0,83	0,67	0,50	0,67	1,00	1,00	0,50	-0,17	1,00	**0,68**
F17	Project nature being non-life-critical	0,17	-0,17	0,33	0,17	0,33	0,17	0,50	0,50	1,00	0,33	**0,33**
F18	**Small project team** – up to 10 members	0,83	0,83	0,83	0,83	0,50	0,33	0,50	0,17	0,83	0,33	**0,60**
Column's average		**0,53**	**0,52**	**0,70**	**0,75**	**0,74**	**0,69**	**0,75**	**0,47**	**0,74**	**0,59**	

Figure 5. Connection between success factors and criteria.

Source: Own elaboration.

3.2.2. Description of interviewed people

A total of fifteen people took part in the model construction by selecting weights. The author tried to select respondents, so that their professional experience, knowledge of Agile management methodologies, and understanding of the IT industry were distributed as evenly as possible. Therefore, the respondents represent both large and small organizations, their knowledge of Agile comes from practice, and some acquired it from university studies. The paragraphs below present all information about the respondents that may be important from the point of view of determining the research context. They are as follows:

a) **Company size and operational scope** - The respondents both found their place in large companies with very extensive scope of activities and smaller ones. Bigger ones are divided into numerous branches, and are highly hierarchical. The others can be so-called "Local companies". This includes Polish companies (up to one hundred employees). This include software houses, companies developing after being established as startups, and providers of small IT services.
b) **IT area** - A significant group of the respondents (11) were people who are in IT departments/teams, but their company operates in a completely different industry. For example, one of the respondents works in the IT department serving Central Europe of a large consulting company.
c) **Orientation of activities** - The company's activities are focused primarily on the outside or inside of the organization. Internal activities are understood as the development of a new application to improve the functioning of the company (e.g. reserving seats at desks), working in the area of the Service Desk, or coordinating the internal work of teams in the company. In this case, 10 people were working in this area. Outside orientation mainly involves working with the client - providing services and products. These will include applications, but also the maintenance of servers and stakeholder websites – 5 people.
d) **Professional position** - Nine people are programmers - in a narrower or broader sense. The role of Project Manager also appears among the respondents. In the organizations where they work, the Agile approach is not the leading form of work. There is a clearly defined framework of the waterfall approach, large projects are carried out classically, and only at a very low level (team level) elements of agility are used. Therefore, it is not strange that the teams can include both a Manager and a Scrum Master.
e) **Experience working in Agile** - Due to the young age of the respondents (between 24 and 32), their work experience is also relatively short. Therefore, it was worth looking at the issue of experience in Agile methodologies. If someone worked in such a specific model for less than, for example, a year, there is a big chance that they would not have had the opportunity to get to know it so well in practice. Fortunately, there were no such people among the respondents. Three years of experience they have prevailed. In the author's opinion, this is sufficient to be able to reliably determine how success factors selected from agility may affect the implemented project.

f) **Experience with Agile before working** - An additional question in the context of experience was about knowledge of Agile before starting professional work in the current position. Almost half of the respondents said that at least one subject related to this type of management had appeared during their studies. The author finds it valuable, that even though most people studied technical fields, they had the opportunity to become familiar with this way of working, at least briefly. The respondents also said that in the company itself, there was little talk about why and what Agile work methodology looked like (even though they declare themselves as organizations that work in this way). Only a few respondents mentioned that the company provided them with short training exclusively in this area. Interestingly, there was no rule here regarding, for example, the organization's size and whether they provided training in this area. At this point, it seems quite random.

g) **Completed field of study -** Technical fields dominated among the respondents. Eight of them studied computer science directly. Five people graduated from a relatively new field of study in Poland - Systems Engineering. It is more focused on optimization and management than just programming. People with this degree are often called "requirements engineers". The author decided to consciously select such a large subset of people with such a professional profile because they form a bridge between IT practitioners and those dealing with management. They have a broader point of view on many project and organizational issues.

h) **Agile focused on product or helping team organization -** The last thing the respondents were asked about (apart from assigning weights to the success factors and success criteria connections) was their assessment of the orientation of the Agile practices used in their teams. The Agile work methodology was designed to deliver products first and foremost. All activities, artifacts, and practices that the team is to undertake are aimed at delivering it (3 respondents). Indirectly, they can influence the team to become more organized. However, this is not an aim itself - according to the definition (Srivastava, et al., 2017). Teams sometimes focus only on implementing Agile practices, without a clear product focus (12 respondents). They then simply focus on trying to organize the team and hope that it will help them deliver the product. However, practice shows that this is not the optimal path. (Dzierżek, 2021).

Summarizing the whole collected data about the respondents indicates two things. irstly, it is the diversity of the group. It is not the case that all people hold the same position. The size of the companies to which people belong also differs. Such diversity allows the author to claim that the research is cross-sectional. They indicate general trends in the beliefs and practical experience of people in the IT industry. On the other hand, there is the education and knowledge of people. Based on the length of experience in Agile work as well as education and knowledge of the methodology before starting the work, the author can have grounds to assess that the group of respondents understood the purpose of the study and that their conclusions

and interpretations can translate into real results and the models created can provide valuable recommendations for business.

3.3. Empirical research results – stage IV - experts' opinions

The expert interviews provided valuable feedback on the Agile project success model, offering insights into its practical usability, validity, potential improvements, and general applicability within IT project management. Here's a breakdown of each expert's profile and contributions.

Experts Profiles:

1. Project Management Specialist (PMO):
   - Experience: 15 years in IT project management, 7 in Agile monitoring and training.
   - Specialty: Agile team oversight, training, consultations.
2. Developer and Scrum Master:
   - Experience: 12 years in IT, extensive experience in Agile teams.
   - Role: Current leader of Scrum Masters.
3. IT Project Consultant, Agile Implementer for Small Organizations:
   - Experience: 9 years in consulting, and Agile project implementation across various organizations.
   - Specialty: Technical and managerial aspects of Agile.

1) Models' usability

Expert 1 found the model technically, and regarding the relationships between elements well-defined. They highlighted its practical applicability for project monitoring and planning, particularly in resource allocation and key area focus.

Expert 2 acknowledged the model's effectiveness in identifying areas for improvement and noted the difficulty in classifying practices as strictly used or unused. They emphasized the balance of allowing team members room for self-correction, as it could foster long-term improvement despite initial challenges.

Expert 3 also saw the model as technically well-constructed but questioned the validity of using generic weights for different teams/projects. The expert suggested that the model's real value lies in giving each team to prescribe exact measures.

2) Validity of results

Expert 1 affirmed the model's alignment with real-world Agile team dynamics, especially in dividing project scope into quality and stability aspects. They stressed the interdependence of factors, cautioning against isolating them; for example, communication might have an indirect but crucial impact on planning outcomes.

Expert 2 appreciated the extensive range of success factors, which they felt realistically captured the components of project success. However, they were surprised by the relatively low

weight assigned to customer satisfaction (C10), suggesting that this may undervalue the customer's role in Agile success.

Expert 3 noted a discrepancy between high ratings for scope-related criteria (e.g., stability) and the relatively low rating for user satisfaction (C7). They agreed with the model's results that consider budget and schedule flexibility, a reflection of Agile's inherent trade-offs.

3) Improvement suggestions

Expert 1 proposed expanding the model with detailed indicators for software quality, such as stability and reliability metrics. Additionally, they recommended integrating a risk assessment mechanism to better prepare teams for practice implementation.

Expert 2 suggested clarifying communication and collaboration factors to make them less ambiguous. They also emphasized incorporating factors for continuous integration and delivery to enhance the model's practical relevance.

Expert 3 recommended a risk assessment module for further practice suggestions and suggested a feedback mechanism for team assessments of Agile practices, allowing for periodic checks on team dynamics and performance.

4) Other comments

Expert 1 emphasized the need for the model to be flexible and updated regularly to stay relevant in a changing IT environment. They also proposed integrating the model into a larger system, incorporating communication tools and progress analysis.

Expert 2 suggested that the model should be adaptable to diverse IT project types. They proposed developing an application or reporting system that could use the model to recommend best practices for specific project criteria.

Expert 3 advocated for embedding the model within a broader analytical framework, cautioning that the results should guide rather than dictate decisions. They suggested piloting the model to refine its utility.

Overall, the experts agreed that the model is technically correct, with well-defined relationships between success factors and criteria, affirming its positive preliminary validation. They noted that it accurately reflects the dynamics of Agile project management, potentially serving as a valuable tool for project planning and monitoring. However, they recommended further refinement in areas like communication, continuous delivery, and software quality indicators. They also emphasized the importance of flexibility and regular updates to the model to maintain relevance. The experts saw the potential for the model to become part of a comprehensive support system for Agile teams. They suggested a dedicated application or reporting system that could extend its usability, supporting tailored project assessments and tracking Agile practices over time.

4. Discussion

4.1. General findings

This section explores research findings, as shown in Figure 5, through participant comments, focusing on the success criteria and selected success factors perspective.

Perspective from the criteria position – C1, C2

The study reveals that the first two criteria (C1 – budget, and C2 - schedule) have lower average ratings than subsequent criteria, with a notable difference of approximately 0.2 points. Additionally, these criteria exhibit more cells with negative weights, indicating that Agile practices may hinder rather than help meet them. A primary factor affecting these criteria is F3, the culture of improvement, which respondents found beneficial for learning from mistakes and developing autonomy. While this approach benefits long-term employee satisfaction and quality, it introduces short-term challenges: correcting mistakes incurs costs, time for error detection, and the engagement of senior staff. This factor could become a liability for projects with tighter deadlines (e.g., six months), although it is expected to yield benefits in longer-term projects.

Self-organization (F4) also impacts C1 and C2. While respondents acknowledge its positive effect on team satisfaction and budget management, the lack of a structured approach occasionally leads to chaotic task management, which may jeopardize project timelines. The feedback culture (F6) was another noteworthy factor; while feedback facilitates quality improvement, it may extend project costs and timelines. Respondents recognized that Agile feedback mechanisms enhance project quality but may compromise time and budget constraints. Similarly, daily meetings (F12) provide a limited positive impact on cost and schedule, as these meetings may devolve into unproductive status updates, driven by participants' need to report rather than engage in genuine problem-solving.

A final consideration related to C1 and C2 was the non-life-critical nature of projects (F17). This factor has a mixed effect, providing a relaxed environment conducive to quality work but potentially reducing productivity for employees who perform better under structured guidance (McGregor, 1960). Overall, respondents noted that Agile principles generally align with team satisfaction and quality but may fall short on cost and schedule criteria.

Perspective from the criteria position – C3-C7

The criteria from C3 to C7 align more closely with Agile methodologies, which focus on delivering functional outcomes. Five of the top six column averages from Figure 5 fall within this group, highlighting Agile's effectiveness in achieving operational stability, reliability, and functional delivery. For example, meeting functional requirements (C6) was rated slightly

lower, partly because of the dynamic nature of requirements under Agile. Respondents appreciated the flexibility to adapt requirements to the customer's evolving needs but noted that such changes require additional resources. Importantly, these criteria (C3–C7) are interrelated: a stable system minimizes risks, reduces unplanned outages, and enhances access to tools and data - ensuring both team efficiency and service continuity. Respondents emphasized that effective initial analysis of requirements (Davis, 1989) is essential to meet these goals, though challenging to achieve. Extensive analysis requires experience, making it resource-intensive.

Perspective from the criteria position – C8-C10

This segment covers team, customer, and end-user satisfaction (C8, C9, C10), with team satisfaction scoring the highest, followed by the customer and then end-user satisfaction. Agile practices focusing inward, such as the roles of the Scrum Master (F9), the non-critical atmosphere (F17), and self-organizing teams (F4, F18), notably contribute to team satisfaction.

For customer satisfaction, respondents perceived Agile's impact as moderate. The client's ability to follow progress (F13) contributes to a sense of control, but the extensive interaction required with the Agile process can strain customer satisfaction. Agile's impact on end-user satisfaction (C8) received surprisingly low ratings. Respondents attributed this to limited direct interaction with end-users, as Agile processes often assume the client represents the end-user's perspective. The client is often a business representative rather than an actual user, creating a gap between user needs and Agile team actions. Although Agile emphasizes end-user orientation, respondents suggested that the lack of direct-user communication limits Agile's impact on true end-user satisfaction.

Perspective from the position of the factors – F7-F9

Examining factors with the highest impact averages across criteria, three factors - F7 (user stories), F8 (sprint planning and backlog usage), and F9 (Scrum Master role) - stand out. User stories (F7) help Agile teams by organizing requirements and testing scenarios, simplifying quality assurance. However, implementing user stories effectively demands rigorous standardization. Sprint planning (F8) is another fundamental Agile practice that structures team efforts, though it alone does not ensure project success. The role of the Scrum Master (F9) emerged as crucial in bridging the team with the Product Owner, who connects the team with the client. This "double bridge" enhances communication, increasing project success likelihood and satisfaction for both the team and client.

Perspective from the position of the factors – F14, F15

Respondents underscored the impact of F14 (appropriate documentation) and F15 (continuous product delivery). Extensive documentation, though contractually required, often consumes time and resources that could be used for project tasks. Assigning documentation

tasks to less experienced team members also risks generating low-quality output. Respondents recommended focusing on essential documentation only, advocating for concise templates to streamline internal documentation. Continuous product delivery (F15), meanwhile, fosters a habit of regular development, aligning with Agile principles of iterative progress. However, respondents cautioned that continuous delivery without periodic reflection may compromise strategic direction.

Perspective from the position of the factor – F18

The team size factor (F18) influenced the efficacy of Agile practices in meeting criteria. Respondents suggested that increasing team size beyond a certain point (e.g., 15-20 members) could dilute Agile's impact, potentially excluding developers from vital sprint review meetings and leading to miscommunication. A smaller team, according to respondents, enables a direct connection between Agile practices and project success.

Perspective from the position of the factors – F7, F8, F11

Finally, respondents highlighted the time dedicated to Agile practices, particularly F7 (user stories), F8 (sprint planning), and F11 (test cases). These factors, requiring the Product Owner's involvement, were seen as essential for effective Agile implementation. Product Owners play a crucial role in translating client priorities into team tasks, underscoring their importance in Agile project success. The respondents recommended including the Product Owner's effectiveness as a future research success factor, emphasizing their role as a central link between the Agile team and the client.

4.2. Conclusions

The research findings offer a wide view of how Agile practices relate to project success criteria, showing both the advantages and challenges of using Agile methods in IT project management.

From the perspective of success criteria, Agile works well in areas like team satisfaction (C8) and delivering functional results (C3-C7). However, it is less effective at meeting strict budget (C1) and schedule (C2) goals. This happens because Agile focuses on flexibility and gradual progress, which improves quality and long-term outcomes but can lead to higher costs and longer timelines in the short term. Practices like self-organization (F4), space for making mistakes and changing them (F3), feedback culture (F6), and daily meetings (F12) reflect Agile's collaborative nature, but they sometimes lack the structure needed to help staying within budget and on schedule.

The study also highlights that Agile does not always fully address end-user satisfaction. While it emphasizes working closely with the customer, in some cases it is not working with a particular end-user. This can result in a gap between what users need and what teams deliver. Teams may benefit from more direct contact with end-users to improve outcomes.

Looking at success factors, certain practices like sprint planning (F8), user stories (F7), and the Scrum Master role (F9) play a key role in connecting team efforts to project success. These practices help teams organize their work, set priorities, and maintain good communication with the client. Respondents also suggested using simpler documentation processes and making time for reflection during continuous delivery to avoid losing focus on the main objectives.

Although Agile aims to orient teams toward product outcomes, this study found that Agile practices primarily foster internal collaboration. Agile practices are strong tools for building teamwork, flexibility, and quality, but they need to be adapted to fit different project goals, especially for managing costs, meeting deadlines, and ensuring end-user satisfaction. These results also highlight areas where Agile methods can be improved, such as better daily meetings or adjusting for larger teams.

5. Limitations and recommendations

This chapter identifies limitations in the research methodology and provides recommendations for enhancing the application of research findings and for future studies on Agile project success. These suggestions are intended to improve the study design, address identified barriers, and propose directions for future investigations.

5.1. Limitations

5.1.1. Extensive response analytics

The research model primarily used averages to calculate the impact of factors, a simplified measure that limits the insights derived. A more comprehensive analysis, using advanced techniques such as cluster analysis or regression analysis, could reveal patterns, trends, or deviations otherwise unseen. Such methods would allow for a deeper understanding of relationships between variables and enable the identification of nuanced insights, potentially offering more robust and actionable findings.

5.1.2. Complexity

While the model aims to reflect real-world Agile project dynamics by linking success factors directly to success criteria. This simplification overlooks the complexity of Agile project environments. The nonlinear and adaptive nature of Agile projects, with their dynamic requirements and dependencies, complicates the possibility of guaranteed outcomes from any

single practice. Attempting to model the intricacies of Agile project management in a linear way only partially captures the fluid nature of these projects, which require constant adjustment and are influenced by external, often unpredictable factors.

5.1.3. Answer declaration

Responses in the study are influenced by participants' theoretical or general knowledge of Agile practices, rather than specific, practical experiences. This can lead to a disconnection between declared practices and their actual application and effectiveness in projects. In Agile IT projects, for instance, development team members may implement practices without fully understanding how these align with broader success criteria (Forlicz, Rólczyński, 2016; Moyer , Syrett, 2019). It makes it challenging to assess the true impact of Agile methods on project outcomes, as responses may reflect assumptions rather than real practices.

5.2. Recommendations

5.2.1. Connection between Success Criteria and Project Success

Although the study links success factors and success criteria, it could benefit from incorporating an overarching project success metric. Building on principia, like Kerzner's approach (Kerzner, 2013), assigning weighted values to individual success criteria based on empirical data could yield a more nuanced understanding of project success. By leveraging data from managers with insights across various projects or portfolios, the model would better represent how individual practices contribute to a project's final success, providing practical and adaptable insights for Agile teams.

5.2.2. Defining project context

The research focuses on IT teams, yet this category includes a wide range of project types, from website development to real-time emotion detection models, each with distinct user types and success criteria. This broad scope may dilute the study's precision. A more context-specific approach - such as focusing on commercial IT projects in a single industry, like education - could yield more accurate, actionable results. To balance applicability with depth, future research might investigate a few closely related project types, offering insights that apply to similar projects without overgeneralizing findings.

5.2.3. Factors and criteria connections

The model's focus on linking success factors with success criteria overlooks dependencies among factors and criteria. For example, the implementation of a factor like sprint reviews (F11) relies on using a backlog (F8), creating a dependency that affects the model's applicability. A more advanced mapping approach could incorporate such interdependencies, enabling a more realistic application of the model. By allowing dependencies to be activated only when prerequisite practices are implemented, the model would more accurately reflect real-world project dynamics.

5.2.4. Research group, quantitative research

The research primarily used qualitative interviews, which offered detailed insights but limited the scope to a smaller sample size. To enable more generalizable conclusions, future studies should consider a quantitative approach, allowing for a larger and more statistically representative sample. Although more resource-intensive, quantitative methods could provide broader insights and a stronger foundation for making widely applicable recommendations.

5.2.5. Partial use of Agile practices

In the current model, Agile practices are assessed on a binary basis—either used ("1") or not used ("0"). This simplification fails to capture varying degrees of practice implementation, which could provide a more realistic picture. Using a scale from 0 to 1 to represent partial adoption of practices might offer more nuanced insights, although it presents challenges in determining non-linear relationships between partial use and project outcomes. Future research could explore these partial relationships by modeling them for selected success factors, enabling a more flexible and detailed analysis.

6. Summary

The primary objective of this paper is to investigate the impact of Agile practices on the success of IT projects, evaluated based on defined, industry-specific success criteria. The research-specific aim is to develop a model that delineates the connections between the Agile practices employed by project teams - viewed as success factors - and the success criteria used to evaluate project outcomes.

The first stage of this research involved an extensive literature review to establish a foundation for understanding Agile practices, artifacts, and tools that are potentially significant for IT project success. This review also identified key project success criteria from existing research, though they are not unique to Agile. Through this process, the author identified 18 Agile success factors (Tab. 1) and selected 10 general project success criteria (Tab. 2). The literature review concluded that the final model should outline the relationships between each Agile factor and each success criterion, providing insights into which factors hold the most significance for project teams and which success criteria are directly supported by specific Agile practices.

To develop this model, the author conducted qualitative research involving in-depth interviews with Agile practitioners currently working on projects managed with Agile methodologies. Participants in this study were asked to assign weights to the relationships between individual Agile factors and success criteria, indicating the relative importance of each factor-criterion connection. A total of 15 practitioners participated, and their responses formed the basis for constructing the final model (Section 3.2). During these interviews, key success

factors within Agile practices were highlighted, particularly practices like thorough planning, maintaining a product backlog, and delivering software incrementally. In contrast, certain practices, such as daily meetings, were rated as having a lower impact on project success criteria. The research also identified specific criteria that Agile practices in this study supported less effectively, such as meeting budget and timeline constraints and achieving high user satisfaction.

The model's initial validation involved follow-up interviews with three domain experts, who assessed the model's accuracy in depicting Agile's real-world application and evaluated its consistency with practical experience. The experts affirmed that the model accurately reflects the connections between Agile practices and project success criteria, as observed in professional settings.

The study's findings contribute to a deeper understanding of how Agile practices affect IT project success, offering a model that both Agile teams and project managers can use as a practical resource to inform resource planning and project implementation. This model illustrates how different Agile practices carry varying levels of impact on the overall success of IT projects, thus providing targeted insights for better project management and resource allocation.

Despite certain limitations, this research presents valuable findings that hold potential for both academic study and practical application in Agile IT project management. Taking into account the research steps described in the paper, it is fully replicable, and the results should differ when selecting respondents from a specific type of IT project or one professional profile (e.g. developers). Future research could delve deeper into individual Agile success factors and work on refining methods to assess their impact more accurately on project success, potentially enhancing the field's understanding of Agile's effectiveness in achieving project goals.

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Appendix

Table 3.
Success criteria frequency table

Project success criterion	References	Frequency
The iron triangle of management		
The project was completed within **budget**	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Siddique, Hussein, 2016), (Wai, Yusof, Ismail, 2012), (Sheffield, Lemetayer, 2013), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Turner, Zolin, Remington, 2010), (Trisnawaty *et al.*, 2021), (Thomas, Fernández, 2008), (Lech, 2013), (Ozturan, Gursoy, Ceken, 2019b), (Phong, Quyen, 2017), (Khalilzadeh, Akbari, Foroughi, 2016b)	14
The project was completed within the **schedule**	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Siddique, Hussein, 2016), (Wai, Yusof, Ismail, 2012), (Sheffield, Lemetayer, 2013), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Turner, Zolin, Remington, 2010), (Trisnawaty *et al.*, 2021), (Thomas, Fernández, 2008), (Lech, 2013), (Ozturan, Gursoy, Ceken, 2019b), (Phong, Quyen, 2017), (Khalilzadeh, Akbari, Foroughi, 2016b)	14
The project **scope** was met (gathered requirements)	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Wai, Yusof, Ismail, 2012), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Turner, Zolin, Remington, 2010), (Trisnawaty *et al.*, 2021), (Lech, 2013), (Ozturan, Gursoy, Ceken, 2019b), (Khalilzadeh, Akbari, Foroughi, 2016b)	10
Other criteria		
The software developed is reliable	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Wai, Yusof, Ismail, 2012), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Thomas, Fernández, 2008), (Lech, 2013),	6
The developed product is easy to use	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Sheffield, Lemetayer, 2013), (Thomas, Fernández, 2008)	3
Flexibility of the product/project is good	(Ahimbisibwe, Cavana, Daellenbach, 2015)	1
The product/project meets users' intended functional requirements	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Siddique, Hussein, 2016), (Wai, Yusof, Ismail, 2012), (Sheffield, Lemetayer, 2013), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Khalilzadeh, Akbari, Foroughi, 2016b)	8
Users were satisfied with the delivered product/project (users' requirements)	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Siddique, Hussein, 2016), (Wai, Yusof, Ismail, 2012), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Trisnawaty *et al.*, 2021), (Thomas, Fernández, 2008), (Lech, 2013), (Ozturan, Gursoy, Ceken, 2019b)	10
The project team is satisfied	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Siddique, Hussein, 2016), (Sheffield, Lemetayer, 2013), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Trisnawaty *et al.*, 2021), (Thomas, Fernández, 2008), (Khalilzadeh, Akbari, Foroughi, 2016b)	9
Top level management of the client's organization is satisfied	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Wai, Yusof, Ismail, 2012), (Thomas, Fernández, 2008)	3
The overall quality of the delivered application is high (or, as agreed on)	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Sheffield, Lemetayer, 2013), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Trisnawaty *et al.*, 2021), (Thomas, Fernández, 2008), (Phong, Quyen, 2017), (Khalilzadeh, Akbari, Foroughi, 2016b)	8
Product/project has added the promised business value	(Siddique, Hussein, 2016), (Wai, Yusof, Ismail, 2012), (Sheffield, Lemetayer, 2013), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Turner, Zolin, Remington, 2010), (Thomas,	11

	Fernández, 2008), (Lech, 2013), (Ozturan, Gursoy, Ceken, 2019b), (Khalilzadeh, Akbari, Foroughi, 2016b)	
Product/Project brings benefits to the client (is profitable for the customer)	(Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Turner, Zolin, Remington, 2010), (Thomas, Fernández, 2008), (Lech, 2013), (Khalilzadeh, Akbari, Foroughi, 2016b)	7
Metrics' benchmarks have been met	(Iriarte, Bayona, 2020)	1
Customer satisfaction	(Ahimbisibwe, Cavana, Daellenbach, 2015), (Siddique, Hussein, 2016), (Wai, Yusof, Ismail, 2012), (Sheffield, Lemetayer, 2013), (Wateridge, 1998), (Iriarte, Bayona, 2020), (Wateridge, 1995), (Turner, Zolin, Remington, 2010), (Trisnawaty *et al.*, 2021), (Thomas, Fernández, 2008), (Phong, Quyen, 2017), (Khalilzadeh, Akbari, Foroughi, 2016b)	12
Company (contractor) made money	(Siddique, Hussein, 2016), (Wai, Yusof, Ismail, 2012), (Iriarte, Bayona, 2020)	3
Experience or knowledge are gained from the project/product	(Wai, Yusof, Ismail, 2012), (Iriarte, Bayona, 2020), (Ozturan, Gursoy, Ceken, 2019b)	3
Personnel training	(Wai, Yusof, Ismail, 2012), (Iriarte, Bayona, 2020), (Ozturan, Gursoy, Ceken, 2019b)	3
All stakeholders satisfaction	(Turner, Zolin, Remington, 2010), (Trisnawaty *et al.*, 2021), (Thomas, Fernández, 2008), (Ozturan, Gursoy, Ceken, 2019b), (Phong, Quyen, 2017), (Khalilzadeh, Akbari, Foroughi, 2016b)	6

Source: Own elaboration.

Table 4.
Agile success factors frequency table

Project success factor	References	Frequency
ORGANIZATIONAL ASPECT		
Executive support is strong	(Chow, Cao, 2008), (Stankovic et al., 2013), (Sheffield, Lemetayer, 2013), (Qatan ani et al., 2021), (Zaleski, Michalski, 2021)	5
Cooperative organizational culture instead of hierarchal	(Chow, Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Freire et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Zaleski and Michalski, 2021)	10
Team culture places high value on face-to-face communication	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013)	10
Agile methodology is universally accepted all over the company	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Alahyari et al., 2018), (de Souza Bermejo et al., 2014)	6
The team is able to work in one place - stationary	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Zaleski and Michalski, 2021)	6
Company facility with proper Agile-style work environment (boards, tables for standups, etc.)	(Chow and Cao, 2008), (Stankovic et al., 2013), (Zaleski and Michalski, 2021)	3
Reward/benefit system is appropriate for	(Chow and Cao, 2008), (Stankovic et al., 2013), (Ghayyur et al., 2018)	3

people working in an Agile		
Organization work is transparent to all teams	(Alahyari et al., 2018)	1
PEOPLE / TEAM		
Friendly and positive environment in the team	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Alahyari et al., 2018), (Freire et al., 2018), (Ghayyur et al., 2018), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	9
Employees are willing to improve and get the chance to do so	(Sheffield and Lemetayer, 2013), (Alahyari et al., 2018), (Freire et al., 2018), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	6
Team members have high competence and expertise	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (Ghayyur et al., 2018), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009), (Zaleski and Michalski, 2021)	12
Team members have great motivation	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009), (Zaleski and Michalski, 2021)	10
Managers have knowledge about the Agile process	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Zaleski and Michalski, 2021)	4
Managers have a light-touch or adaptive management style	(Chow and Cao, 2008), (Stankovic et al., 2013), (Zaleski and Michalski, 2021)	3
The team works coherently, is self-organizing, and multifunctional	(Chow and Cao, 2008), (Stankovic et al., 2013), (Shahane, Jamsandekar and Shahane, 2014), (Alahyari et al., 2018), (Qatanani, Al-Tawara and Qusef, 2021), (Freire et al., 2018), (Ghayyur et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	11
Good customers relationships	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Qatanani, Al-Tawara and Qusef, 2021), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	8
PROCESS		
Tangible outcomes after each iteration	(Srivastava et al., 2020), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (Ghayyur et al., 2018), (de Souza Bermejo et al., 2014), (Misra, Kumar and Kumar, 2009), (Zaleski and Michalski, 2021)	9
Culture of open feedback	(Chow and Cao, 2008), (Stankovic et al., 2013), (Srivastava et al., 2020), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (Ghayyur et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	13
Test and Lean approach – for instance using retrospectives	(Srivastava et al., 2020), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (de Souza Bermejo et al., 2014), (Misra, Kumar and Kumar, 2009)	6
Following an Agile-oriented requirement management process	(Chow and Cao, 2008), (Stankovic et al., 2013), , (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (Ghayyur et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	10

Following an Agile-oriented project management process, facilitated by Scrum Master	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Freire et al., 2018), (Ghayyur et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	11
Strong communication focus with daily meetings	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Freire et al., 2018), (Ghayyur et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009)	11
Honoring regular working schedule – no overtime	(Chow and Cao, 2008), (Stankovic et al., 2013)	2
Strong customer commitment and presence	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Misra, Kumar and Kumar, 2009)	8
Customer having full authority	(Chow and Cao, 2008), (Stankovic et al., 2013), (Qatanani, Al-Tawara and Qusef, 2021)	3
TECHNICAL		
Well-defined coding standards upfront	(Chow and Cao, 2008), (Stankovic et al., 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (de Souza Bermejo et al., 2014), (Misra, Kumar and Kumar, 2009), (Zaleski and Michalski, 2021)	7
Pursuing simple design	(Chow and Cao, 2008), (Stankovic et al., 2013), (Ghayyur et al., 2018)	3
Rigorous refactoring activities	(Chow and Cao, 2008), (Stankovic et al., 2013), (Qatanani, Al-Tawara and Qusef, 2021)	3
Right amount of documentation	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Qatanani, Al-Tawara and Qusef, 2021), (Ghayyur et al., 2018), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Zaleski and Michalski, 2021)	8
Regular delivery of software	(Chow and Cao, 2008), (Stankovic et al., 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (Ghayyur et al., 2018), (de Souza Bermejo et al., 2014), (Zaleski and Michalski, 2021)	9
Delivering the most important features first	(Chow and Cao, 2008), (Stankovic et al., 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Alahyari et al., 2018), (Freire et al., 2018), (Ghayyur et al., 2018), (de Souza Bermejo et al., 2014), (Zaleski and Michalski, 2021)	9
Correct integration testing	(Chow and Cao, 2008), (Stankovic et al., 2013), (Shahane, Jamsandekar and Shahane, 2014), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013)	5
Appropriate technical training for the team	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Ghayyur et al., 2018), (Tonelli et al., 2013), (de Souza Bermejo et al., 2014), (Goh, Pan and Zuo, 2013), (Misra, Kumar and Kumar, 2009), (Zaleski and Michalski, 2021)	11
PROJECT		
Change over plan approach	(Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Freire et al., 2018), (Ghayyur et al., 2018)	4
Project nature being non-life-critical	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Qatanani, Al-Tawara and Qusef, 2021), (Ghayyur et al., 2018)	5

Project type being of variable scope with the emergent requirement	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Ghayyur et al., 2018)	4
Projects with a dynamic, accelerated schedule	(Chow and Cao, 2008), (Stankovic et al., 2013)	2
Projects with a small team	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Shahane, Jamsandekar and Shahane, 2014), (Qatanani, Al-Tawara and Qusef, 2021), (Freire et al., 2018), (Tonelli et al., 2013), (Misra, Kumar and Kumar, 2009)	8
Projects with no multiple independent teams	(Chow and Cao, 2008), (Stankovic et al., 2013), (Zaleski and Michalski, 2021)	3
Projects with up-front cost evaluation done	(Chow and Cao, 2008), (Stankovic et al., 2013)	2
Projects with up-front risk analysis done.	(Chow and Cao, 2008), (Stankovic et al., 2013), (Sheffield and Lemetayer, 2013), (Ghayyur et al., 2018), (Zaleski and Michalski, 2021)	5

Source: Own elaboration.

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ADVANCING EDUCATION THROUGH VIRTUAL REALITY IN THE MANAGEMENT AND PRODUCTION ENGINEERING FIELD OF STUDY

Kinga STECUŁA

Silesian University of Technology, Faculty of Organization and Management; kinga.stecula@polsl.pl, ORCID: 0000-0002-6271-2746

Purpose: The purpose of this paper is to explore the application of virtual reality (VR) as an innovative tool for education in the field of Management and Production Engineering. It aims to demonstrate how VR can be effectively integrated into laboratory classes to enhance students' learning experiences and practical skills. Additionally, the paper highlights the role of the teacher in guiding and supporting students in using VR technology for educational purposes.
Design/methodology/approach: The paper utilizes a case study approach to examine the use of a specific virtual reality application in the field of Management and Production Engineering. The study involves the implementation of VR-based laboratory classes, where students engage in various training modules of the given selected VR application, including both theoretical and practical tasks in a simulated production environment. The methodology includes a presentation of the VR application's modules, the tasks for students, the organization of VR-supported laboratories, and the role of the instructor in facilitating the learning process.
Findings: The study showed that it is possible to use virtual reality in higher education, especially in the context of classes in the field of management and production engineering. The possibility of creating and implementing VR applications that realistically reproduce the production environment and enable conducting training and classes for students of technical studies has been confirmed. The research results confirmed that VR is a practical tool for teaching production lines, technological processes, machine parameters, equipment operation, quality control, and safety rules in the production hall. All these elements can be effectively implemented under controlled conditions in the university, without the need for physical presence in the industrial plant.
Originality/value: This paper offers a perspective on integrating virtual reality into laboratory classes within the field of Management and Production Engineering, highlighting its transformative potential for traditional teaching methods. The study emphasizes VR's value as a modern educational tool that enhances applied learning by providing hands-on practice in addition to theoretical knowledge, allowing students to engage actively and perform tasks independently.
Keywords: virtual reality, production engineering, education, management, technology, production line, machines.
Category of the paper: Research paper.

1. Introduction

Knowledge and technology development, strongly observed in recent years, has profoundly impacted various fields of human activity, including education. Among immersive emerging new technologies virtual reality (VR), often associated with entertainment including games, has gained significant attention for its potential to widely enhance the learning experience. It gives a chance for interactive education. Virtual reality VR offers a growing range of applications, including the entertainment industry (Rogers et al., 2021; Stecuła, 2022), both, on-the-job and safety training (Makransky, Klingenberg, 2022; Norris et al., 2019; Stecuła, 2023), advanced specialist training and teaching (Baniasadi et al., 2020; Hsiao et al., 2021), marketing, ads and ways of popularization (Ozdemir, 2021; Shen et al., 2020; Zhu, Wang, 2022), as well as education (Brown et al., 2021; Dergham, Gilányi, 2019; Pinto et al., 2019). In higher education, particularly in technical and engineering disciplines, VR offers unique opportunities to improve traditional teaching methods. Virtual reality technology can provide its users with an immersive and interactive environment; this means that it has the potential to be used as a novel activation for students in education. Education needs to be improved by using new devices and tools. Proper use of VR can enrich education, as it enables full engagement of students by letting them be in the created world. There, they can see, touch and interact with many objects (that are the subject of a given class). Hence it is very important to select appropriate scenarios that will be compatible with the class program and schedule. Also, virtual reality allows for real-time feedback, which is important for students and teachers, as well as in the context of assessing learning outcomes.

The Management and Production Engineering field of study requires a deep understanding of complex production and technological processes, machine operations, managing manufacturing environments, enterprise, different resources and many more. What is more, this field educates engineers of the XXI century that needs different skills, predispositions and knowledge – both practical and theoretical (Kaźmierczak, 2016). All the mentioned aspects require different methods and tools from than oral lectures and theoretical discourses. In technical courses, it is necessary to use methods that will allow students to familiarize themselves with the taught program in a practical way and as closely related to the real production environment as possible. Hence, physical laboratories, workshops, and industrial visits are an efficient way of understanding the studied aspects. However, these methods often face limitations, including accessibility, safety concerns, and the logistical challenges of providing all students with this experience. Virtual reality presents a solution to these challenges by enabling the creation of immersive, simulated environments that replicate real-world production settings. Through VR, students can engage in interactive learning experiences that allow them to explore production lines, operate machinery, and understand production processes in a risk-free environment. This not only enhances their theoretical understanding but also allows them to develop practical skills that are essential for their future careers.

This article discusses a practical example of using virtual reality to conduct classes in the field of study of Management and Production Engineering. The author has characterized a selected application intended for training and educational purposes, from the perspective of using it in laboratory classes. The application consists of several training modules – both theoretical and practical. The practical modules contain various tasks that must be performed in the virtual environment of production plants. The trainee (student), among others, familiarizes themselves with selected machines, their functionalities, parameters, and selected technological lines. Their tasks include, among others, creating a layout of the technological line, operating a CNC machine, changing the parameters of the selected machine, carrying out a product quality control, and many others. This article presents an example application and describes how to use it in classes, the learning effects of the proposed laboratories, and the benefits of using the selected VR application in studying. Then, the role of the teacher (trainer) performed during classes using virtual reality is emphasized. The teacher not only transfers knowledge, but also supports students in using the new medium, helps them fully use the potential of VR, provides guidance on tasks, monitors their progress continuously, and also ensures the safety of those using VR

2. A proposal of using the selected VR application in laboratories

2.1. Characteristics of the VR application "Production Plant"

The application, which was chosen for use in the Management of Production Engineering course, was developed by EpicVR (EpicVR, 2024), a company specializing in creating applications for virtual and augmented reality (AR), but also mixed reality (MR). The selected application, named "Zakład produkcyjny" ("Production plant") is dedicated to virtual reality, which means that the user must have VR goggles, visualizing the virtual world and its elements designed in the application, as well as controllers that act as virtual hands. Thanks to the controllers, the user can interact with virtual objects. The application presents a production plant and consists of several modules, including a theoretical module and practical modules. Being in the virtual world of the application, the user can select specific modules from the application level. The application consists of:

- general instructional module,
- Occupational Health and Safety (OHS) module (theoretical and practical),
- practical modules.

General instructional module

The application offers a general training module that aims to familiarize users with the virtual environment and learn how to move around in this kind of world. In this module, the participant learns step by step how to use the goggles and controllers, performing activities such as moving, grabbing and dropping objects, passing through different spaces, turning on and stopping the line, etc. For beginners, this may be a challenge, because moving around in the virtual world has its own specifics, but it is relatively intuitive. Completing this module is crucial for further use of virtual reality. People who have already had contact with VR technology can skip this module.

OHS module (theoretical and practical)

The OHS module consists of four parts:

- occupational health and safety engineering,
- hazards in production plants,
- personal protective equipment,
- fire hazard.

This module, first of all, contains of slides with the basic knowledge in the given topic (one of four topic mentioned above). After the knowledge section there are test questions. These multiple-choice questions allow the trainee to answer questions related to the production environment in the context of occupational health and safety in VR. After answering, the user sees their result: the number of correct answers. These parts are therefore used to learn and verify knowledge – in a virtual environment. If the user passes the theoretical part, they are transferred to the production hall, where they must perform practical tasks related to the given topic. For example, in the section on fire hazards, the user must put out the fire in a production plant. The user is in the production plant and must perform some tasks, for example, put on personal protective equipment, turn on the alarm, find a fire extinguisher and perform other activities, and finally – put out the fire. Figure 1 shows the screenshot of the menu in the OHS module.

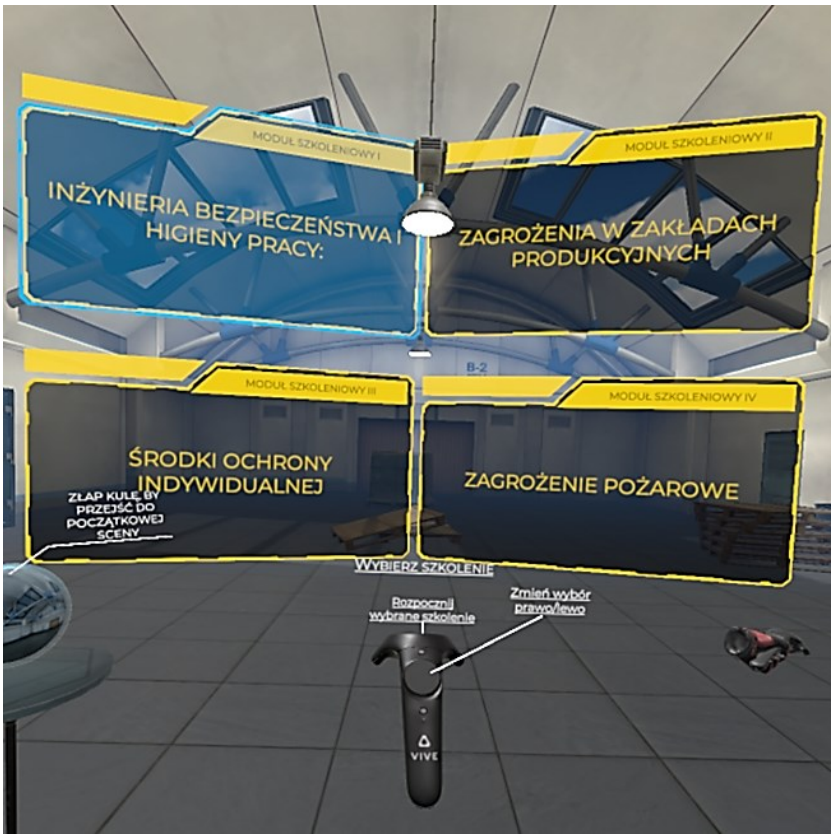

Figure 1. Screenshot of the OHS module of the VR application "Production plant" developed by EpicVR.

Practical modules

The practical modules include the following:

- furniture production,
- SMT systems production,
- CNC production,
- aluminum profile production.

By selecting one of the four available modules in the virtual world, the user is automatically transferred to the selected area, where they stand in front of a production line layout. On this layout, their task is to correctly arrange the machines so that they create the correct technological line, consistent with the theme of the given module. Using virtual hands (controllers), the user grabs miniatures of machines and places them in the appropriate positions. After completing the arrangement of machines, the user clicks a green button, which is used to confirm the arrangement, and then receives feedback on the correctness of the created technological line. Machines that have been placed correctly are highlighted in green, while those placed incorrectly are highlighted in red. Additionally, when grabbing each machine, the user sees its name and a short description, and also has the ability to rotate it in the hand to view it from every side. This task has no time limit, which allows the user to spend as much time as they need to complete it. Because of this, if they make a mistake, they will be

able to understand where the mistake occurred, which will make it easier to remember the correct solution in the future.

The next task in each of the modules is to change the parameters of the given machines. The user must download a given machine (machine miniature) from the layout and then change the selected parameter, which is, for example, the processing speed in the case of a machine tool. It is worth noting that the choice of parameters depends on the specifics of the machines and the task.

After correctly arranging the production line, the user is transferred to a full-size technological line, where the machines are mapped on a 1:1 scale. In this virtual environment, the user can approach each machine and see the entire technological line up close.

In each of the modules, the user must also start a given technological line and perform subsequent tasks, which are provided in the form of verbal (in Polish) and visual (subtitle) instructions. Additionally, some elements are highlighted to make it easier for the user to find the appropriate components or buttons to use. Thanks to this, step by step, the user learns how a given technological line works, which allows them to better understand the technological processes, imagine the machines and acquire practical skills.

In addition to the above-mentioned tasks, each module also contains additional tasks that vary depending on the specifics of the module. In some modules, in addition to the tasks listed (laying out a technological line on a mock-up, changing machine parameters, starting a technological line), the user must perform other tasks that are intended to deepen their knowledge and skills. These additional tasks allow for an even more comprehensive understanding of production processes, which makes each module unique and adapted to different aspects of production management and engineering.

In the furniture production module, the user gets to know with the following machines: two milling machines, two edge banding machines and a drilling machine, and from these five machines the user needs to create two technological lines.

In SMT systems production module, the user gets to know Surface Mount Technology (SMT). This module shows the subsequent operations performed on Printed Circuit Boards (PCBs). The user deals with machines such as versaprint (for precisely applying solder paste to PCBs using a screen-printing process), nxt (placing components), hotflow (reflow over for melting solder paste onto PBC to create permanent solder joints), and check station (for inspection of the quality of solder paste applied or soldered components on PCB). In this module, another task is to change the size of six PCBs. This module includes also a quality control process. The user must perform a quality control of all boards on the check station to pass the module.

In the CNC products module, users can familiarize themselves with the operation of various machines, such as CNC machines, lathes, and a robotic arm. After setting up the technological line and entering the appropriate machine parameters, the user, located on the full-size technological line, must pick up the element and place it in the appropriate place in the CNC

machines and the lathe, one by one. The user must place the part in the appropriate place in the machine. Then the machine must be closed, and the machining process must be start. After the machining is finished, the user must safely open the machine, remove the element, and place it on the conveyor belt. This must be done several times. The next task is also to place the processed elements safely in the box. At the next station, where the robot arm is, the user has the task of controlling the robot arm. Figure 2 (a) shows the task of placing four machines on the layout. Figure 2 (b) shows the finished task – the technological line is properly prepared. Figure 3 (a) shows placing the detail in the CNC machine, and Figure 3 (b) presents the already processed detail placed in the machine.

In the last module, the production of aluminum profiles, the user has 5 machines at their disposal. The machines must be arranged in the right order in the technological line. These machines are the following: an oven, a squeezer machine, a saw, a heat treatment machine and a packaging machine.

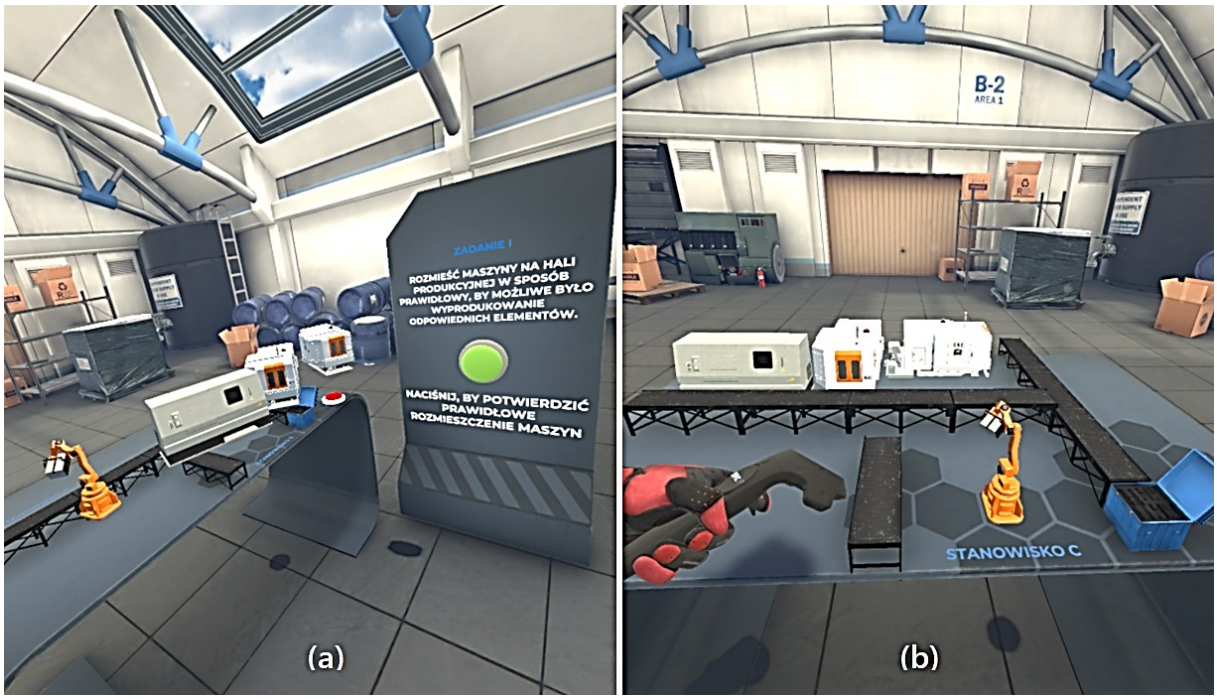

Figure 2. Screenshot of the practical module of CNC production: (a) – the beginning of the task of placing machines, (b) – finished task.

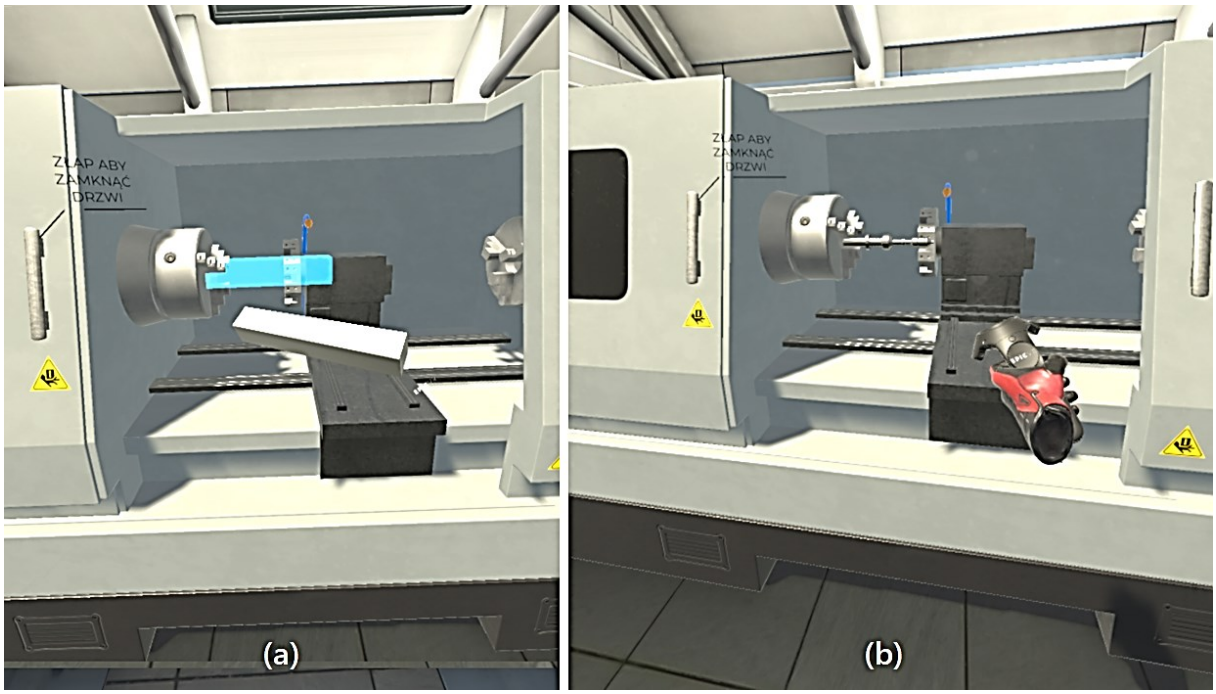

Figure 3. Screenshot of the practical module of CNC production: (a) – placing the detail in CNC machine, (b) – processed detail.

2.2. The use of VR application in laboratories from Production Engineering

In the application "Production Plant", selected production processes are generally presented, which means that their specificity is not discussed or presented in great detail. Due to this, the application is particularly suitable for first-year students of the first cycle (engineering) studies in the field of Management and Production Engineering. In the first year, these students deal with quite general topics that introduce them to the secrets of the field. Hence, the use of this application in the first semester is justified. The subject in which the implementation of this application is planned is Production Engineering, and the chosen form of classes is laboratories.

The author of this article, who teaches this subject, has prepared a set of steps that aim to implement and effectively use this application in the teaching process during laboratory classes. Due to this, students will have the opportunity to familiarize themselves with the basic issues related to production processes in the virtual reality environment, which will be the foundation for further, and more advanced education in the following years of studies. The steps include:

- **Preparing the room**

To conduct classes using virtual reality, an appropriate laboratory room is necessary. A larger room equipped with several stations with virtual reality goggles and controllers is preferred, so that several students from a smaller laboratory group can use virtual reality at the same time. Small laboratory groups (several people) are also preferred; otherwise conducting classes and monitoring students' work, as well as ensuring safety, will be very difficult. The room must be spacious, and in such a room, any objects such as desks and chairs that may pose a threat to those using virtual reality should be avoided.

- **Equipment purchase and setup**

The laboratory must be equipped with several VR stations, each consisting of VR goggles, controllers, and a designated space for students to move around safely. The goggles must be calibrated first. Each station should be preloaded with the VR application "Production Plant", ready for use.

- **Familiarization of students with regulations**

Before students put on the VR goggles, they are introduced to the safety regulations for using VR goggles, health and safety instructions and best practices for using virtual reality technology. Also, it is important to know contraindications to using virtual reality equipment and possible complications.

The instructor must ensure that all students are aware of potential contraindications, such as motion sickness or epilepsy, and verify that no student has any medical condition that could be exacerbated by the use of VR. Students are required to read and understand the safety guidelines (sign a consent form if necessary) and be briefed on emergency procedures in case of discomfort or technical issues.

- **Initial familiarization**

Each student starts with the general instructional module of the VR application (described previously in this paper). This module is crucial to ensuring that all students, regardless of their previous experience with VR, can use the technology effectively.

- **Engagement with theoretical and practical modules**

Students use subsequent virtual reality modules in subsequent laboratories. During this, they learn, familiarize themselves with the theoretical and practical content developed in the application, develop, expand their imagination, and gain experience and knowledge. They also learn independent thinking, and develop problem-solving skills, logical thinking, and reasoning. It is worth mentioning that during such labs, students engage more senses than during traditional lectures.

After completing each task, students receive immediate feedback from the application. This allows students to identify and correct their mistakes. Moreover, if a student makes a mistake, they have the opportunity to retry the task without any time pressure. This iterative process helps reinforce learning and ensures that students fully understand the correct setup and operation of the technological line.

- **Broder context and discussion**

It is important that the content shown in virtual reality is also discussed during the lecture. It is suggested that individual technological lines and individual machines are discussed in more detail during the lecture.

After the VR lab session, the students meet for a debriefing session. Here, they discuss their experiences, the challenges they faced, and the lessons they learned. The instructor can also provide additional information, answer questions, and connect the VR experience to broader production engineering concepts.

- **Additional tasks**

Students are suggested to prepare additional assignments or reports related to a given technological line. The additional assignments were to supplement the knowledge acquired during the VR session. Students could be asked to write a short report or reflection on their experience, describing what they learned and how it applies to real-world manufacturing engineering scenarios. This step helps reinforce the learning outcomes and encourages a deeper reflection on the practical applications of the acquired skills.

By applying this structured approach, the VR application "Production Plant" can be effectively integrated into Production Engineering laboratories, providing students with a comprehensive, immersive learning experience that can mix theoretical knowledge and practice.

The use of the presented VR application in Production Engineering labs significantly enhances students' learning effects. Using these VR applications can improve students' comprehension and retention of complex production processes. The ability to visualize and manipulate virtual machines fosters a deeper understanding of machine operations, technological line setup, and production workflows. Secondly, the VR environment allows for immediate feedback, enabling students to learn from mistakes and correct their approach in real-time, which reinforces learning and improves the memorization process. VR application helps students to get to know and understand selected basic engineering processes and technologies and ways of solving typical engineering tasks, particularly in relation to the organization of production processes and production management - in the field of production engineering. Additionally, the the hands-on experience with virtual machines and production lines prepares students for real-world industrial settings, equipping them with practical skills and a better understanding of safety protocols, machine parameters, and production efficiency. Overall, these classes using VR technology not only make learning more engaging, but also significantly enhance the practical skills and confidence of students in the field of production engineering.

3. Benefits of using the proposed VR application

Implementing the proposed VR application in production engineering laboratories offers several significant benefits, enhancing both the educational experience and the practical skills of students. They include the following:

- Enhancement of student engagement.
- Hands-on experience with virtual production machinery.
- Safe space for experimentation and learning from mistakes.

- Possibility of repetition of tasks.
- Real-time feedback on performance.
- Adaptability to different learning levels and student needs.
- Active learning and participation.
- Immediate application of theoretical knowledge in a practical context.
- Learning through experience.
- Development of problem-solving skills in a simulated environment.
- Virtual experience in a risk-free environment.
- Preparation for advanced courses by building foundational knowledge.
- Promotion of independent learning through self-guided modules.
- Enhancement of understanding of machinery and technological lines.
- Reinforcement of learning objectives through practical application.
- Providing a new method of learning with visual, auditory, and kinesthetic elements.
- Eliminating the need to organize trips to production plants.
- Possibility to repeat a task without wear and tear on equipment.
- Integration with Industry 4.0 technologies for modern learning.
- Preparation students for real-world manufacturing and production roles.
- Familiarization of students with VR technology.
- Development of skills relevant to Industry 4.0 and smart factories.
- Enhancing CV with experience in advanced simulation tools.
- Development of critical thinking and decision-making skills.
- Increase in university capacity to offer advanced technological education.
- Enhancement of the university's reputation for innovative teaching methods.
- Enhancement of student satisfaction and engagement with modern tools.

As the list above shows, virtual reality in education brings many benefits to both students and the university.

4. The role of the teacher (trainer) during a VR session

The role of the teacher during a virtual reality session is key, transforming from a traditional teacher to an instructor, guide and mentor. In VR learning environment, the teacher's responsibilities extend far beyond conveying information.

Before beginning any VR session, the teacher must conduct a identify if any students have contraindications to using VR technology. This includes understanding if any students have conditions such as motion sickness, epilepsy, severe vertigo, or other forms of locomotion weaknesses that could be intensified by VR use. Students with these conditions might

experience discomfort, disorientation, or other health risks when exposed to the immersive VR environment. What is more, due to some sickness and conditions, some of the students are not allowed to use VR.

To ensure safety, the teacher should ask students if they have any known issues with VR or similar technologies and provide them with a clear explanation of what the VR experience will entail. This allows students to make informed decisions about their participation. In some cases, alternative assignments or accommodations might be necessary to ensure that all students can engage with the course content in a way that is safe and effective for them.

During the session, the teacher should remain alert, closely monitoring students for any signs of discomfort or adverse reactions, such as dizziness, nausea, or disorientation. They should be prepared to pause the VR activity immediately if a student exhibits any of these symptoms and have a plan in place to assist them, whether that involves taking a break, adjusting the settings, or switching to a different learning activity.

Additionally, the teacher should ensure that students are aware of the importance of taking breaks during VR sessions to prevent eye strain and reduce the risk of motion sickness. Regular breaks are an essential part of maintaining student well-being during extended VR use.

Then, the teacher must ensure that students are well-prepared to use the VR equipment, such as goggles, controllers, and any associated software. This includes providing detailed instructions on how to operate the technology and addressing any initial technical challenges that students may face.

As students begin to immerse themselves in the VR experience, the trainer's role becomes one of continuous support and guidance. The teacher is there to help students navigate through the virtual environment, ensuring they understand how to interact with the simulations and utilize the various features of the VR application effectively. This guidance is crucial in helping students fully engage with the learning material, allowing them to explore concepts in a hands-on, experiential manner that traditional teaching methods cannot offer.

Moreover, the teacher plays a critical role in encouraging students to think critically and solve problems within the virtual environment. By providing targeted prompts, questions, and feedback, the teacher helps students to not only complete tasks but also to reflect on their actions and decisions, deepening their understanding of the subject matter. This active engagement is essential for maximizing the educational benefits of VR, as it encourages students to apply theoretical knowledge in a practical context.

In addition, the teacher is responsible for creating an inclusive learning environment in which all students feel comfortable and supported. This includes offering assistance to students who may be less familiar with technology or who may have difficulties adapting to the VR environment. By being approachable and responsive to student needs, the teacher can help build confidence and ensure that all students benefit equally from the VR experience. In essence, the teacher's role in a VR session is comprehensive and multifaceted. It combines mainly the following:

- technical support,
- instructional guidance on tasks,
- transferring knowledge,
- learning facilitation,
- safety monitoring,
- monitoring of students' progress and engagement,
- feedback provision,
- critical thinking stimulation,
- inclusivity advocacy,
- emotional encouragement and support,
- pre-session health screening,
- break management,
- post-session debriefing,
- equipment maintenance,
- collaboration facilitation.

Through active involvement, the trainer not only enhances the effectiveness of the VR learning experience but also ensures that it is accessible, engaging, and educational for all students. This important and expanded role reflects the evolving nature of education in the digital age, where teachers must adapt to new technologies while maintaining their commitment to student learning and development.

5. Conclusions

The integration of virtual reality into the Management and Production Engineering field has the potential to modernize education, providing students with immersive experiences that traditional methods cannot match. In this paper, the author presented a VR application called "Production Plant" and showed how this application can be used in laboratories on the subject of Production Engineering. The study showed that it is possible to use virtual reality in higher education, especially in the context of classes in the field of technical studies. The research results confirmed that VR is a practical tool for teaching production lines, technological processes, machine parameters, equipment operation, quality control, and safety rules in the production hall. All of these elements can be effectively implemented under controlled conditions in the university, without the need for physical presence in the industrial plant.

By simulating real-world environments, in the mentioned example - different technological lines, virtual reality allows students to bridge the gap between theoretical knowledge and practical application, thus preparing them more effectively for the challenges of the professional

world. Furthermore, VR's ability to provide a safe, controlled environment for experimenting with technological processes and machines is highly beneficial. It enables students to explore and learn from mistakes without the risks and costs associated with real-world errors. The immersive nature of VR also fosters greater engagement and motivation among students, leading to improved learning outcomes and knowledge memorizing.

As the technology continues to evolve, its accessibility and ease of use will likely increase, making VR a more integral part of educational programs in the Management and Production Engineering field. Institutions that embrace this technology early on will not only provide their students with an innovative educational experience, but also position themselves as leaders in the advancement of educational methods.

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OPTIMIZING THE SELECTION OF PROJECT MANAGEMENT APPROACHES – RESEARCH FINDINGS

Anna STRONCZEK[1*], Piotr ŚCIGAŁA[2]

[1] AGH University of Krakow; stroncz@agh.edu.pl, ORCID: 0000-0001-9343-936X
[2] Kyndryl Global Services Delivery Centre Polska, Wroclaw; kontakt@piotrscigala.pl, ORCID: 0009-0006-2934-6058
* Correspondence author

Purpose: The purpose of this article is to analyze the optimal application areas of predictive, adaptive, and hybrid project management approaches, identifying key factors influencing their selection and evaluating their impact on project success and stakeholder satisfaction.
Design/Methodology/Approach: This study employs a quantitative research methodology, combining a comprehensive literature review with survey data collected from 37 project management professionals. The analysis focuses on project characteristics, organizational factors, and external environment variables to establish correlations between these factors and the selection of project management methodologies.
Findings: The findings indicate that hybrid project management approaches are the most widely used due to their balance between structured planning and flexibility. Predictive approaches are more effective for projects with stable requirements and fixed timelines, while adaptive approaches excel in dynamic environments with evolving requirements. The study highlights the significant role of senior management support and the customization of methodologies in achieving project success.
Research Limitations: The study is limited by its reliance on self-reported data, which may introduce bias, and the geographic concentration of respondents, primarily in Poland. Future research could expand the sample size and include a more diverse population to validate the findings across different cultural and organizational contexts.
Practical Implications: The article provides actionable insights for organizations aiming to optimize their project management approach. By understanding the factors influencing methodology selection, practitioners can better align project management strategies with specific project and organizational requirements, ultimately enhancing project efficiency and stakeholder satisfaction.
Originality/Value: This study contributes to the existing body of knowledge by offering empirical evidence on the comparative effectiveness of predictive, adaptive, and hybrid project management approaches. Its practical recommendations support organizations in making informed decisions regarding methodology selection, addressing a critical gap in project management research.
Keywords: project management, predictive approaches, adaptive approaches, hybrid methodologies, project success.
Category of the Paper: research paper.

1. Introduction

In the face of rapid technological advancements and constantly evolving market demands, organizations are under growing pressure to deliver successful projects that meet both strategic goals and stakeholder expectations. Traditional project management approaches, such as predictive or plan-driven models, are often inadequate for projects that require adaptability and responsiveness to change. Consequently, adaptive and hybrid approaches, including Agile and mixed-method models, have gained prominence for their ability to navigate complexity and prioritize flexibility.

Despite the popularity of various project management approaches, there remains a critical gap in understanding the optimal conditions and criteria for their effective application. The objective of this study is to bridge this gap by providing a comparative analysis of predictive, adaptive, and hybrid project management strategies, aiming to identify the factors influencing the choice of approach in diverse project environments. This research not only addresses the challenges of aligning project characteristics with suitable methodologies but also offers empirical insights based on survey data to guide organizations in selecting the most effective project management approach. By addressing this research gap, the findings contribute to enhancing project efficiency, improving outcome predictability, and ultimately achieving higher levels of project satisfaction among stakeholders.

2. Literature review

Project design and implementation have become critical aspects of organizational strategy, as reflected by the increasing volume of publications dedicated to project management and the development of diverse project management approaches and methodologies aimed at supporting organizations in achieving their strategic objectives. The origins of modern project management date back to the 1950s, marked by the introduction of network planning techniques such as the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) (Reed et al., 2024; Stretton, 2007). Since then, project management has evolved significantly, from practices primarily used in engineering and construction to comprehensive methodologies applicable across a wide range of industries.

2.1. Traditional (predictive) project management approaches

Predictive, or traditional, project management approaches rely on thorough, upfront planning and assume that project requirements can be clearly defined from the outset. The Waterfall methodology and PRINCE2 are well-established examples, structured around

sequential project phases and emphasizing control through detailed documentation and rigid schedules (Bentley, 2020). These methodologies, however, tend to struggle in environments marked by high levels of uncertainty, where requirements may change during the project lifecycle. Research suggests that projects with fixed or highly regulated scopes, as well as those in industries with lower variability, such as construction or manufacturing, benefit most from predictive approaches (Wright, 2022; Ciric et al., 2021).

The primary advantage of predictive methodologies lies in their ability to provide stability through clear scope definitions and fixed budgets, making them suitable for large-scale projects with multiple dependencies (Sheffield, Lemétayer, 2010; Shiv, Doraiswamy, 2012). However, rigid adherence to initial plans can result in costly overruns and delays if changes become necessary, a frequent risk in today's rapidly changing business environment (Pace, 2019). Studies by Reed et al. (2024) and Rotaru (2021) also underscore that while predictive approaches provide effective structure and accountability, they can limit flexibility, making them less adaptable to the evolving needs and expectations of stakeholders.

2.2. Adaptive project management approaches

In response to the limitations of traditional project management, adaptive methodologies have gained popularity, especially in industries characterized by high innovation and changing requirements, such as software development. The Agile approach and its associated methodologies, like Scrum and Kanban, prioritize flexibility and continuous feedback over rigid planning, which enables iterative development cycles that adapt to evolving stakeholder needs (Cooke, 2014; Reed et al., 2024). The Agile Manifesto, published in 2001, formalized these principles, advocating for customer collaboration, rapid response to change, and incremental project delivery (Schwaber, Sutherland, 2020).

Adaptive methodologies focus on delivering value through frequent iterations, or sprints, which help to address stakeholder feedback continuously. Research by Bentley (2020) shows that Agile approaches are particularly advantageous for projects with uncertain requirements, as they allow project teams to modify the project scope and priorities based on real-time feedback, rather than pre-defined milestones. Wright (2022) emphasizes that adaptive project management has a strong focus on customer satisfaction, with scope defined by the evolving needs of the customer rather than a fixed project plan.

While Agile has shown success across various industries, its reliance on less formalized documentation and processes requires a cultural shift within organizations, fostering a no-blame environment, collaborative teams, and high levels of self-organization (Pace, 2019). Despite its advantages, the Agile approach may introduce risks in highly regulated environments where documentation and fixed scope are mandatory (Azenha et al., 2021). Research by Reed et al. (2024) highlights that, while Agile is widely praised for its adaptability, its lack of a clearly defined hierarchy and increased dependence on cross-functional teams can create challenges for organizations accustomed to traditional management structures.

2.3. Hybrid project management approaches

As project requirements have become increasingly diverse, hybrid methodologies have emerged, blending elements of both predictive and adaptive approaches to achieve a balance between structure and flexibility. This middle ground is particularly valuable for projects where components like regulatory compliance benefit from a structured approach, while customer-driven features demand adaptability (Gemino et al., 2021; Brendzel, 2024). Hybrid project management approaches, often combining the upfront planning of Waterfall with the iterative execution of Agile, enable organizations to harness the stability of traditional models while maintaining the responsiveness of adaptive methodologies (Wright, 2022).

Studies reveal that hybrid approaches are commonly applied in complex projects that require multiple stakeholder groups and have a broad scope (Reed et al., 2024; Piwowar-Sulej, 2021, Wolniak, 2022a, 2020b). By maintaining a predictive framework for regulatory or highly sensitive components and incorporating iterative Agile cycles for development tasks, hybrid methodologies address a broader range of project needs. Research also indicates that hybrid approaches facilitate improved stakeholder satisfaction by aligning project deliverables with both regulatory and market-driven requirements (Bentley, 2020; Cooke, 2014).

2.4. Selection criteria for project management approaches

The choice of project management approach depends on several factors, including project complexity, regulatory requirements, team size, and customer involvement. Wright (2022) notes that highly regulated projects with extensive compliance requirements may necessitate a predictive approach, while projects with evolving or uncertain requirements benefit more from adaptive methodologies. Additionally, organizational culture plays a significant role in approach selection; bureaucratic organizations may struggle to adopt Agile, while collaborative environments are often better suited to adaptive approaches (Piwowar-Sulej, 2021).

Research by Reed et al. (2024) suggests that the experience and expertise of project teams also impact approach selection, as teams familiar with Agile can more effectively implement adaptive methodologies. Moreover, factors such as project team structure and communication frequency affect the feasibility of hybrid approaches, as they require both structured documentation and iterative, cross-functional collaboration.

In summary, the literature on project management approaches highlights the advantages and limitations of predictive, adaptive, and hybrid methodologies. Predictive approaches offer stability for projects with defined requirements and minimal need for flexibility, while adaptive methodologies excel in environments characterized by uncertainty and rapid change. Hybrid approaches combine elements of both, providing a tailored approach to projects with mixed needs. However, selecting the optimal project management methodology requires careful consideration of organizational, project-specific, and external factors. As the field of project

management continues to evolve, understanding the optimal conditions for each approach is essential to maximizing project success and stakeholder satisfaction in an increasingly complex business landscape.

3. Research method

This study employs a quantitative research approach to identify optimal application areas for different project management approaches – predictive, adaptive, and hybrid – and the key factors influencing their selection. Given the increasing interest in project management methodologies and the limited empirical research on their practical effectiveness, a hypothetico-deductive method was chosen to provide objective measurements and identify quantitative relationships between project characteristics and methodology selection (Apanowicz, 2005; Sułkowski et al., 2021)

3.1. Literature review and formulation of research questions

The research process began with a comprehensive review of the literature to understand the evolution, application, and efficacy of various project management approaches. The review highlighted the need for a practical analysis of project management approaches, particularly in assessing their effectiveness across diverse organizational environments. Based on insights from the literature, two research questions were formulated:

1. What are the optimal application areas for predictive, adaptive, and hybrid project management approaches?
2. What factors influence the selection of a project management approach for a specific project?

These questions guide the study's empirical focus on identifying factors that inform the choice of methodology and examining how different project management approaches align with project and organizational characteristics.

3.2. Data collection instrument: survey questionnaire

To gather data, a survey questionnaire was developed, a common tool for data collection in project management research (Reed et al., 2024). The questionnaire is structured into five sections:

1. Demographics – questions capturing respondents' background, including work experience, certifications, and familiarity with different project management methodologies.
2. Project characteristics – questions addressing the scope, requirements stability, and project end-date flexibility.

3. Delivery organization characteristics – this section focuses on factors such as senior management commitment, customization of project management methodologies, and organizational type.
4. Evaluation of project outcomes – questions capturing respondents' assessment of project success in terms of stakeholder satisfaction, budget compliance, and timeline adherence.
5. External environment – questions about regulatory requirements, market changes, and legal constraints affecting the projects.

The questionnaire comprises a total of 33 questions. Respondents were project management professionals, providing usable responses from 37 individuals collected between June and July 2024.

3.3. Survey population and sample description

The sample comprises a diverse group of project management professionals with an average of 9.5 years of experience in project environments and certifications in methodologies such as Scrum, PMP, PRINCE2, and Lean. While the majority of respondents (76%) were based in Poland, participants also included individuals from countries such as India, Slovakia, and the United States. This diversity in experience levels and project management certifications enhances the study's ability to generalize findings across varied project environments.

Among the certifications reported, Scrum was the most common, with 15 responses (Figure 1). The second most popular certification was Project Management Professional (PMP), issued by the Project Management Institute (PMI), with 11 responses. Agile-related certifications ranked third with 10 responses. PRINCE2 certification followed with 7 responses, while Six Sigma (4 responses), Lean (3 responses), and Scaled Agile Framework (SAF, 2 responses) were less frequently reported. Less common certifications, such as Kanban, Large Scale Scrum (LeSS), and Programme Management Professional (PgMP), were mentioned by only 1 respondent each.

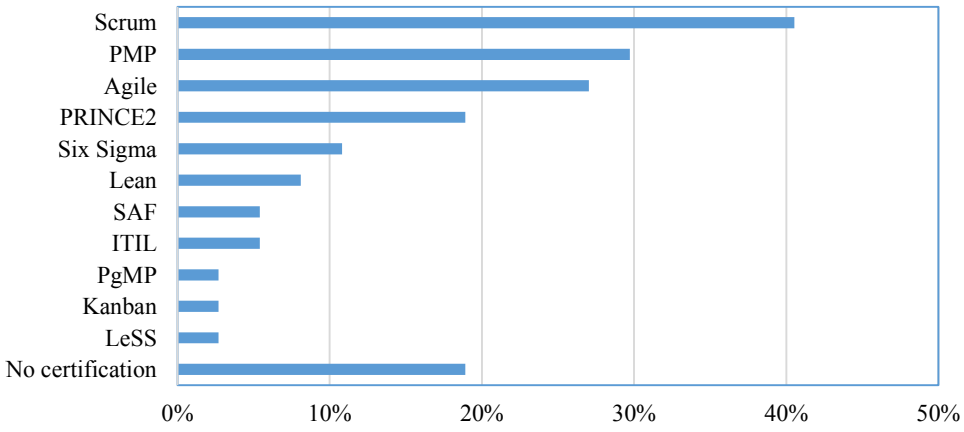

Figure 11. Respondents' project management certificates.

Source: Own study.

The respondents' familiarity with project management methodologies varies significantly, reflecting both traditional and adaptive practices (Figure 2). The Waterfall methodology is the most commonly used approach, with 78% (29 out of 37) of respondents having practical experience. Only 4 respondents (11%) reported theoretical knowledge of Waterfall, while another 4 respondents (11%) were not familiar with it. This high level of practical familiarity highlights the continued relevance of traditional approaches in many projects.

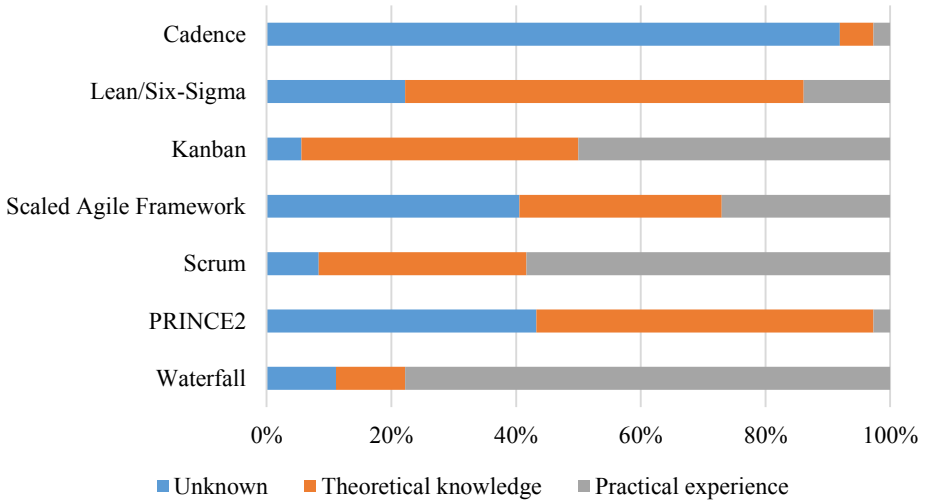

Figure 22. Respondents' familiarity with project management methodologies.
Source: Own study.

The Scrum methodology is slightly less prevalent in practice, with 57% (21 responses) indicating experience. However, this still reflects its widespread adoption as a cornerstone of adaptive project management. In comparison, the Kanban methodology sees considerable application, with 49% (18 responses) reporting practical experience. Interestingly, Kanban also exhibits a strong theoretical base, as 17 respondents (46%) have theoretical knowledge, and only 2 (5%) are unfamiliar with it. The Scaled Agile Framework (SAF) is less commonly applied, with only 27% (10 responses) having practical experience. However, 37% (12 respondents) are familiar with SAF theoretically, while 41% (15 respondents) are entirely unfamiliar with this methodology, highlighting its niche status within adaptive project management. PRINCE2, while recognized for its certifications, is rarely applied in practice. Although 54% (20 respondents) reported theoretical knowledge of PRINCE2, only 1 respondent had used it practically, and 43% (16 respondents) were unfamiliar with it. This disparity underscores the gap between PRINCE2's reputation and its real-world application. Another methodology with a significant gap between theoretical and practical familiarity is Lean/Six-Sigma. A majority (65%, 24 respondents) have theoretical knowledge of this methodology, but only 14% (5 respondents) have applied it in projects. This suggests that Lean/Six-Sigma is more commonly perceived as a process optimization tool rather than a standard project management approach. For niche methodologies such as Cadence, familiarity

is minimal. Only 1 respondent reported practical experience, 2 respondents (5%) had theoretical knowledge, and 92% (34 respondents) were entirely unfamiliar with it.

Training methods also reflect trends in project management adoption. Self-study was the most common form of acquiring knowledge, especially for hybrid (16 respondents) and predictive approaches (15 respondents). Training for the adaptive approach was the most popular, with 76% of respondents having received Agile training. Notably, 11 respondents had attended extensive Agile training sessions lasting more than 10 days.

The traditional approach also saw considerable training, with 51% of respondents reporting formal training, primarily at expert levels (8 respondents for sessions longer than 10 days). In contrast, the hybrid approach had the highest proportion of respondents with no training or self-study (8 responses), indicating a gap in structured learning opportunities for hybrid methodologies.

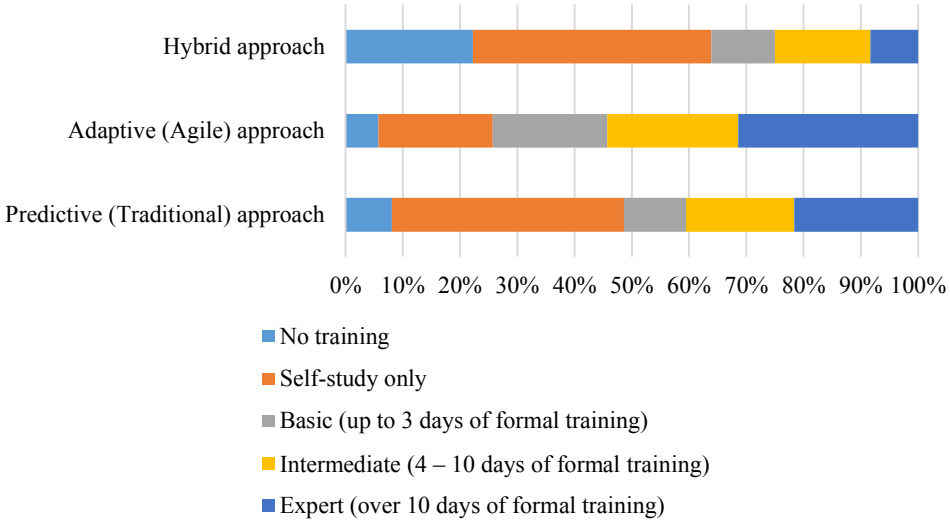

Figure 33. Received training in project management approaches.

Source: Own study.

These findings illustrate a clear divergence between theoretical familiarity and practical application across methodologies. Traditional approaches like Waterfall dominate in practice, while adaptive and hybrid methodologies are more often studied than applied. Addressing the barriers to practical implementation, particularly for PRINCE2, SAF, and Lean/Six-Sigma, could improve the balance between knowledge and usage.

3.4. Research variables

To address the study's objectives, several key variables were defined, classified into three categories: external factors, organizational characteristics, and project-specific factors.

- External factors – this includes regulatory requirements, the level of political and market changes, and industry type (Wright, 2022).

- Organizational characteristics – key organizational variables include organizational culture (bureaucracy vs. collaboration), senior management support, and organization type (e.g., private, public sector).
- Project-specific factors – variables include project size, team size, budget, dependencies, and the frequency of customer and internal communication.

3.5. Data analysis approach

The data collected from the survey was analyzed using descriptive and inferential statistics. Descriptive analysis was employed to understand the distribution of project management approaches and methodology customization across different project and organizational characteristics. The study also employs correlation analysis to examine relationships between project attributes and methodology selection, particularly to test the hypothesis that the choice of project management approach depends on project complexity, requirement stability, and external factors.

3.6. Limitations of the method

One limitation of the survey-based approach is the reliance on self-reported data, which may introduce biases based on respondents' personal perceptions and experiences. Additionally, the regional focus on respondents from Poland may limit the generalizability of findings to other geographic regions. Future studies may expand the scope to include a more diverse, global sample to validate the findings across different organizational and cultural contexts.

In conclusion, the methodology of this study combines literature review insights with quantitative data from experienced project management professionals. The structured approach provides an evidence-based foundation for understanding the criteria influencing project management methodology selection, which aims to support organizations in aligning their approach with project-specific needs for improved project outcomes.

4. Results and discussion

The survey data, collected from 37 project management professionals, provides valuable insights into the application areas and selection criteria for predictive, adaptive, and hybrid project management approaches. The findings reveal diverse preferences and considerations across project types, organizational settings, and external factors, helping to illuminate how various methodologies are employed in practice to enhance project outcomes and stakeholder satisfaction.

4.1. Distribution of Project Management Approaches

The results show that hybrid project management is the most commonly used approach among respondents, applied in 43% of projects. The adaptive approach follows at 27%, with the predictive approach used in 24% of projects. Only 6% of respondents indicated that no formal project management approach was applied. This distribution aligns with current research indicating that the hybrid approach is favored for its balance of structure and flexibility, making it suitable for complex projects with diverse requirements (Reed et al., 2024).

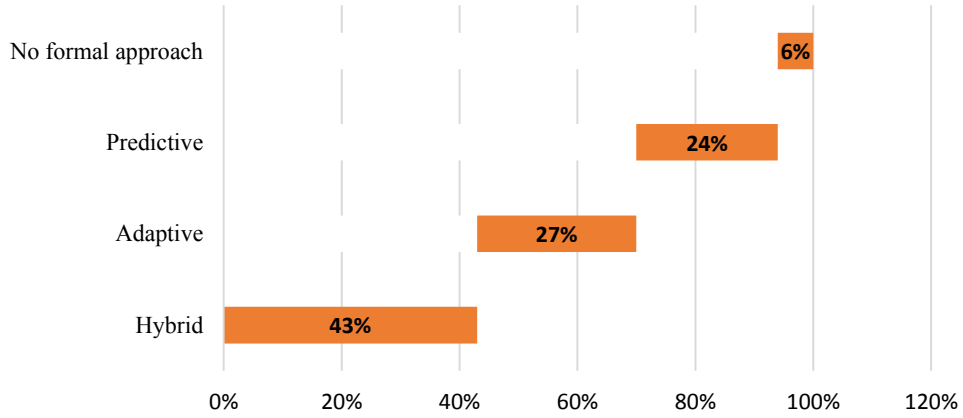

Figure 4. Project management approach used in projects described by respondents.
Source: Own study.

The preference for hybrid methodologies reflects the need to combine the structured planning of predictive approaches with the flexibility of adaptive methods, particularly in projects with regulatory constraints and evolving stakeholder needs (Gemino et al., 2021). This finding supports the literature, which notes that hybrid approaches are increasingly used in modern project management due to their adaptability to complex and dynamic project environments (Wright, 2022).

4.2. Project characteristics influencing methodology selection

The survey indicates that project characteristics, such as scope clarity, expected changes, and project end-date flexibility, are significant factors in determining the appropriate project management approach.

- Scope clarity – approximately 35% of projects had a well-defined and complete scope at the outset, favoring the predictive approach, which benefits from stable requirements. In contrast, projects with evolving scopes (27%) were more likely to adopt adaptive methodologies, as these allow for adjustments based on stakeholder feedback and emerging requirements (Bentley, 2020; Shiv et al., 2012).

- Flexibility of project end dates – for almost half of the projects (46%), flexibility was possible for key dates but not the final deadline. Projects with stricter timelines (32%) were more inclined toward predictive or hybrid approaches, which provide structured planning and control mechanisms essential for meeting fixed deadlines (Sheffield, Lemétayer, 2010). Projects with flexible timelines were more open to adaptive approaches, accommodating iterative cycles and ongoing adjustments.
- Requirement stability – projects with medium stability in requirements (54%) predominantly used hybrid approaches, blending predictive planning with adaptive execution. Fixed requirements, present in 20% of projects, correlated with predictive approaches, whereas projects expecting frequent changes preferred adaptive approaches.

4.3. Organizational characteristics and methodology customization

Organizational culture, management support, and methodology customization emerged as influential factors in methodology selection.

- Organizational culture and senior management support – projects with strong senior management support (86%) reported higher success rates, consistent with findings that executive involvement facilitates alignment with strategic goals and resource allocation (Reed et al., 2024; Piwowar-Sulej, 2021). Organizations with collaborative cultures were more likely to adopt adaptive or hybrid approaches, while more hierarchical cultures tended toward predictive approaches.
- Customization of methodologies – most organizations reported adapting their chosen project management methodologies to align with organizational and project-specific needs. A high degree of customization was noted in 11% of projects, with moderate customization in 73%. This trend is supported by existing literature indicating that tailoring methodologies improves their applicability and effectiveness (Pace, 2019). Hybrid projects, in particular, benefitted from customized methodologies, as they often required blending aspects of both structured and flexible approaches to meet varied project demands (Rotaru, 2021).

The level of adoption of project management methodologies further highlights the practical alignment of organizational characteristics with the chosen approaches. Figure 5 presents the distribution of methodology adoption levels among respondents, emphasizing the prominence of hybrid methodologies due to their adaptability to diverse project needs. This reflects the findings that organizations often customize methodologies to better fit their structure and project-specific requirements.

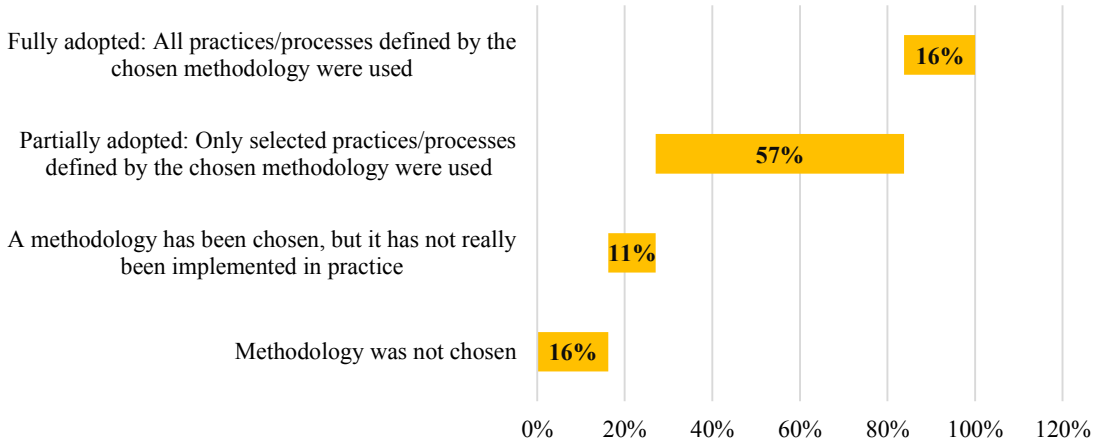

Figure 5. Level of project management methodology adoption among surveyed organizations.
Source: Own study.

4.4. External environment characteristics and approach selection

The external environment, including regulatory and market changes, influenced approach selection, especially in highly regulated or volatile industries.

- Regulatory requirements – projects with moderate to high regulatory demands (61%) were more likely to use predictive or hybrid methodologies, which provide structured processes to ensure compliance (Wright, 2022). Projects in industries with lower regulatory requirements leaned towards adaptive approaches, emphasizing flexibility and rapid response to changing conditions.
- Market changes – projects impacted by frequent market changes favored adaptive and hybrid approaches to allow responsiveness to shifting demands. Adaptive methodologies, such as Scrum, were particularly effective for projects in fast-paced industries, as they enabled iterative updates and continuous alignment with market trends (Reed et al., 2024).

4.5. Communication and stakeholder involvement

Effective communication and stakeholder involvement were essential across all project management approaches. The survey results show that:

- Customer involvement – projects with regular customer involvement, particularly those with daily or weekly interactions (76%), reported higher stakeholder satisfaction. Adaptive and hybrid approaches excelled in maintaining regular customer feedback, a key factor for projects with changing requirements.
- Internal communication – frequent communication within the project team, especially daily meetings (60%), was common in adaptive and hybrid projects, supporting ongoing coordination and quick problem-solving. Predictive approaches, while typically less communicative, still benefited from structured periodic updates to keep all stakeholders informed (Cooke, 2014).

The survey also provided detailed insights into the impact of the external environment on the selection of project management approaches. Figure 6 presents the success metrics reported by respondents, including budget adherence, schedule compliance, and stakeholder satisfaction. The data shows that the highest levels of success were achieved in projects utilizing hybrid approaches.

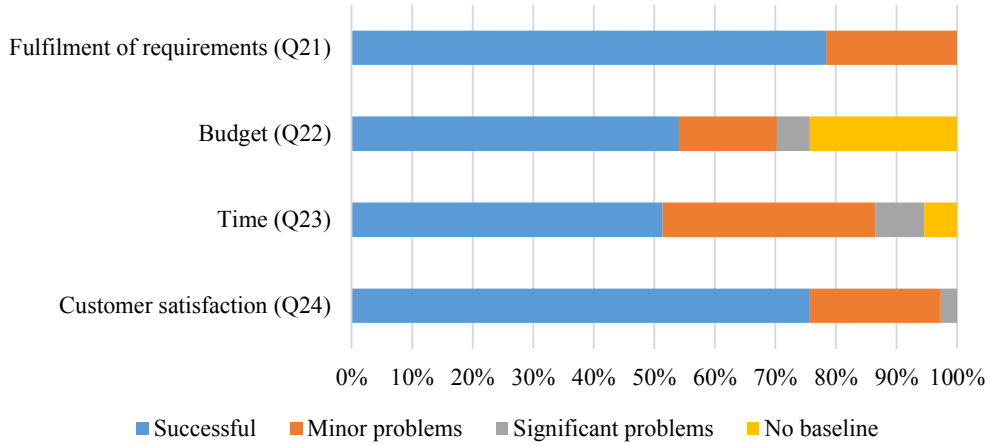

Figure 6. Success metrics reported for projects.

Source: Own study.

Figure 7 compares the success metrics achieved by different project management approaches (predictive, adaptive, and hybrid). The analysis reveals that hybrid approaches, owing to their flexibility in responding to changing requirements, achieved the highest levels of stakeholder satisfaction. In contrast, predictive approaches excelled in budget and schedule compliance.

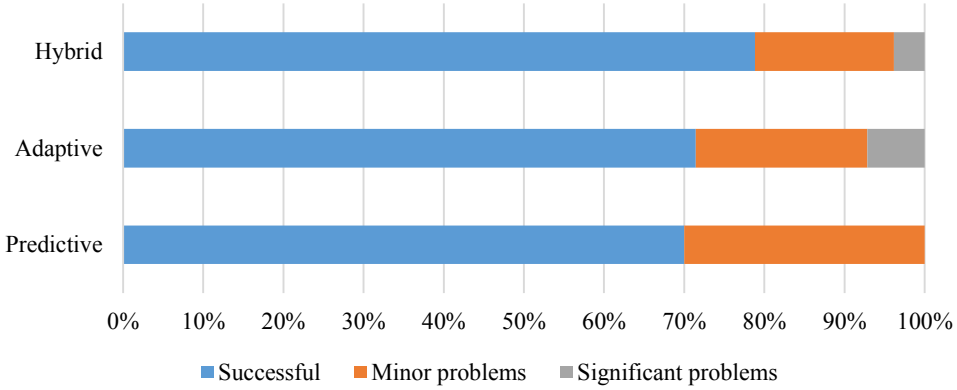

Figure 7. Comparison of reported project success metrics with applied project management approach.

Source: Own study.

These findings underscore the importance of tailoring the approach to the characteristics of the external environment, particularly in dynamic and demanding contexts where hybrid approaches can provide a better balance between flexibility and structure.

4.6. Project outcomes and success factors

The study found that project success was closely tied to the alignment of project characteristics with an appropriate project management approach. Such alignment facilitates the effective use of resources, enhances stakeholder satisfaction, and increases the likelihood of achieving key project objectives.

- Budget and timeline adherence – predictive and hybrid projects demonstrated higher success rates in adhering to budget and schedule constraints. This success stems from the structured nature of these approaches, which emphasize meticulous upfront planning, clearly defined deliverables, and robust monitoring mechanisms. These methodologies reduce uncertainty, ensuring better control over time and cost (Bentley, 2020). Notably, predictive approaches excel in projects with low variability, whereas hybrid methods provide additional flexibility when moderate changes are expected.
- Stakeholder satisfaction – adaptive and hybrid approaches excelled in delivering higher levels of stakeholder satisfaction. This was primarily due to frequent feedback loops, iterative adjustments, and a focus on meeting evolving customer needs. These principles, central to Agile methodologies, foster active collaboration and dynamic problem-solving, which are crucial in projects with shifting priorities. These findings align with Agile methodologies, enabling project teams to respond dynamically to stakeholder inputs, ensuring continuous alignment with project goals (Schwaber, Sutherland, 2020).

Figure 8 explores the interplay between project size, complexity, and environmental changes on the effectiveness of selected project management approaches. This figure underscores the distinct advantages and limitations of predictive, adaptive, and hybrid methodologies, highlighting their effectiveness across various project scenarios.

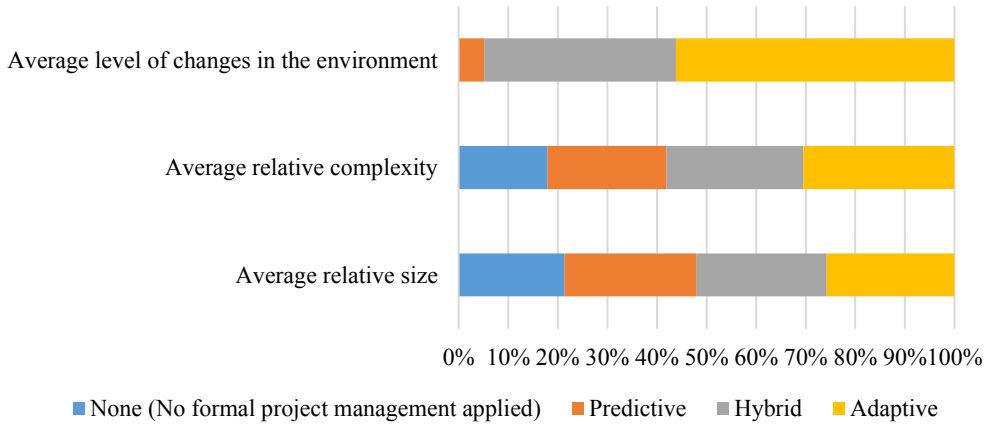

Figure 8. Effectiveness of project management approaches across project size, complexity, and environmental dynamics.

Source: Own study.

The analysis presented in Figure 8 highlights several important trends regarding the effectiveness of project management approaches in various contexts. Predictive methodologies emerge as the most effective for projects characterized by well-defined requirements, low complexity, and stable external conditions. These approaches provide a robust framework for ensuring accountability and achieving budget and timeline goals. Predictive methods are particularly favored for large-scale projects, where detailed upfront planning and strict adherence to timelines and budgets are critical to success.

In contrast, adaptive approaches demonstrate their strength in smaller projects that face high uncertainty and frequent changes in requirements or external environments. The success of adaptive methodologies lies in their capacity for real-time adjustments, enabled by iterative processes and stakeholder engagement. This iterative nature allows teams to respond dynamically to evolving needs, ensuring that the project remains aligned with stakeholder expectations despite shifting circumstances. Adaptive methodologies also foster innovation and creativity, making them ideal for exploratory or high-risk projects.

Hybrid methodologies, on the other hand, are most effective in medium-to-large projects with mixed levels of complexity and partially defined requirements. Their combined structure and flexibility make them particularly suitable for projects requiring both rigorous regulatory compliance and adaptability to evolving market demands. By blending these elements, hybrid approaches address the dual demands of maintaining control in regulated aspects of the project while allowing for adaptability in areas subject to change.

The study underscores that the selection of an appropriate project management approach is a critical determinant of project success. Projects with well-established plans and predictable external factors often achieve greater budgetary control and predictability when managed through predictive or hybrid approaches. Conversely, in dynamic environments, adaptive methodologies support greater innovation and stakeholder alignment, particularly when rapid adjustments are necessary to address evolving external conditions. Ultimately, this correlation highlights the need for organizations to develop a nuanced understanding of their project environment and to customize their methodologies accordingly.

5. Conclusion

In an era of rapid technological advancement and shifting market demands, organizations face increasing pressure to choose effective project management approaches that align with their unique project requirements and strategic objectives. This study examines the optimal application areas for predictive, adaptive, and hybrid project management approaches, exploring key factors that influence their selection in diverse project environments.

Through a survey of project management professionals, the research reveals that hybrid approaches, combining the structured planning of predictive methods with the flexibility of adaptive methodologies, are the most widely applied. Hybrid methodologies are especially favored in complex projects requiring compliance with regulatory demands alongside responsiveness to evolving stakeholder needs. The study also finds that predictive approaches are well-suited for projects with stable, clearly defined requirements and fixed timelines, while adaptive methodologies excel in environments characterized by high uncertainty and frequent changes.

The results of this study affirm that the selection of a project management approach significantly influences project success and stakeholder satisfaction. Predictive approaches offer stability and control, making them suitable for projects with well-defined requirements and fixed timelines. Adaptive approaches, in contrast, are better suited for projects with changing requirements and high uncertainty, where flexibility and customer feedback are crucial. Hybrid approaches, which combine aspects of both, prove to be the most versatile, accommodating projects with diverse needs and varying levels of predictability.

These findings emphasize the importance of a tailored approach to project management. Organizations benefit from customizing methodologies to suit specific project requirements and adapting to external and internal factors. Furthermore, the strong correlation between senior management support, effective communication, and project success highlights the need for organizational commitment to ensure the chosen project management approach aligns with both strategic objectives and operational realities.

In summary, while predictive, adaptive, and hybrid approaches each offer distinct advantages, the optimal choice depends on a careful analysis of project, organizational, and external environment factors. This study contributes to the understanding of how organizations can leverage diverse project management approaches to enhance efficiency, responsiveness, and overall project success.

The results emphasize the need for organizations to carefully assess project, organizational, and external factors when selecting a project management approach. Key determinants such as requirement stability, organizational culture, and regulatory constraints play critical roles in shaping the choice of methodology. Additionally, the study highlights the importance of senior management support, frequent communication, and stakeholder involvement as essential factors for project success.

This study contributes to the growing body of knowledge on project management by offering empirical insights into how organizations can strategically align their project management approaches with project-specific needs. By understanding the criteria for selecting the most appropriate approach, organizations can enhance project efficiency, responsiveness, and stakeholder satisfaction, ultimately improving overall project outcomes in today's complex business landscape.

This study highlights the significance of selecting the right project management approach based on project-specific, organizational, and environmental factors. However, several areas remain for further exploration to deepen understanding and applicability in diverse contexts:

- Longitudinal studies on methodology effectiveness – future research could involve longitudinal studies to assess the impact of project management approach selection over the project lifecycle. This would provide insights into how different approaches affect long-term project success, adaptability to evolving stakeholder needs, and sustained stakeholder satisfaction.
- Cross-industry comparisons – while this study includes projects from various industries, a detailed, industry-specific analysis would be valuable. Research comparing approach effectiveness across high-tech, healthcare, manufacturing, and financial sectors, for example, could reveal unique needs and success factors specific to each industry.
- Influence of organizational culture and size – this study indicates that organizational culture and structure impact the choice and success of project management approaches. Future studies could explore these variables in greater depth, examining how factors such as company size, hierarchical structures, and collaboration levels shape project management practices.
- Impact of emerging technologies – with the rapid rise of AI, machine learning, and advanced project management software, future research could investigate how these technologies interact with traditional and adaptive methodologies, influencing efficiency, decision-making, and outcome predictability.
- Hybrid approach customization models – given the popularity of hybrid methodologies, further research could focus on developing frameworks or models to guide the customization of hybrid approaches for different project types, enabling a structured yet adaptable strategy for project managers.

These directions offer pathways to refine project management practices, providing tailored recommendations that organizations can apply to maximize project success in increasingly complex environments.

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ARTIFICIAL INTELLIGENCE IN MANUFACTURING – SYSTEMATIC LITERATURE REVIEW

Wojciech TARASIUK[1*], Katarzyna HALICKA[2]

[1] Bialystok University of Technology; wojciech.tarasiuk@pb.edu.pl, ORCID: 0009-0005-7717-648X
[2] Bialystok University of Technology; k.halicka@pb.edu.pl, ORCID: 0000-0001-6370-8995
* Correspondence author

Purpose: The purpose of this paper is to explore the current state of research on artificial intelligence in manufacturing. The paper aims to identify key trends, leading authors, institutions and research topics, as well as to identify the main areas of scientific interest in this field.
Design/methodology/approach: The research objectives were achieved by using a systematic literature review and bibliometric analysis. The study used Web of Science and Scopus databases, where searches were conducted according to specific keywords and inclusion criteria, such as document type, language and publication time range (2015-2024). The collected data was then analyzed for the distribution of documents by type, year of publication, country, institution, author, and co-occurrence of keywords, which made it possible to extract major thematic clusters and research trends.
Findings: The analysis revealed five thematic clusters representing key research areas, alongside a rapid growth in publications from 2019, particularly in countries such as China, the United States, and India. These findings highlight an increasing global focus on AI's application in manufacturing.
Originality/value: This article offers a comprehensive and up-to-date analysis of research on artificial intelligence in manufacturing, covering publications up to 2024. By identifying five key thematic clusters, it provides unique insights that will benefit researchers, industry practitioners, and decision-makers aiming to integrate AI into manufacturing processes. The study provides a better understanding of research trends and developments in the field, making it a valuable resource for researchers, industrial practitioners and decision makers interested in integrating AI into manufacturing processes.
Keywords: artificial intelligence, manufacturing, systematic literature review.
Category of the paper: literature review.

1. Introduction

The modern world is witnessing a continuous technological transformation, with the technology available on the market evolving at an unprecedented pace. Advances in areas such as big data, the Internet of Things (IoT) and artificial intelligence are not just the domain of the world's largest industrial centers, but are transforming the market on a global scale (Rymarczyk, 2020). Businesses are facing challenges that were unimaginable a dozen years ago. These include globalization, increasing customer requirements and the need to make decisions quickly in a dynamic environment (Lina, 2022).

In response to these challenges, artificial intelligence could become a key tool (Patalas-Maliszewska et al., 2020), enabling manufacturing companies not only to manage resources efficiently, but also to respond more quickly to changing trends and deliver more personalized services (Huang, Rust, 2018). With its ability to analyze vast amounts of data, AI is speeding up decision-making processes while opening the door to new business models (Patalas-Maliszewska, 2020).

AI encompasses a broad spectrum of technologies, including machine learning, neural networks, and expert systems, which collectively enable machines to perform tasks that traditionally required human intelligence. These technologies are instrumental in addressing contemporary manufacturing challenges, such as optimizing resource utilization, reducing downtime through predictive maintenance, and enhancing product quality through automated defect detection. The application of AI extends beyond operational efficiency, offering transformative potential in areas such as product personalization and sustainable energy management.

Despite the growing interest in the application of artificial intelligence (AI) in the manufacturing sector, there is a significant gap in the literature regarding a comprehensive understanding of where research on the use of AI in manufacturing sector stands. Additionally, many studies are based on case studies or a specific technology, which limits their generality and universality. Therefore, there is a need for a broad literature review that not only identifies and summarizes existing research, but also highlights untapped opportunities and future research directions. This study aims to provide a comprehensive analysis of the current state of research on AI applications in manufacturing, identifying key trends, thematic clusters, and emerging opportunities. By leveraging bibliometric analysis and a systematic literature review, the study not only highlights the progress achieved in this domain but also identifies gaps and areas for future exploration. The findings serve as a valuable resource for researchers, practitioners, and policymakers, offering insights into the strategic deployment of AI to drive industrial innovation and sustainability.

2. Literature review

One of the most straightforward definitions of artificial intelligence (AI) is that it is a field of study concerned with the development of systems that are capable of performing tasks that would typically require human intelligence (Boden, 2016). Some researchers, on the other hand, point to the fact that AI does not just match the capabilities of the human mind, but sometimes surpasses them (Angelov et al., 2021), this may be due to the fact that this field of science is so broad (Arinez et al., 2020).

The sub-areas of artificial intelligence include, but are not limited to, expert systems, neural networks and machine learning. It should also be noted that these fields are not inseparable. Very often they overlap to form complex structures (Arias, 2022).

The development of expert systems can be traced back to the second half of the twentieth century. Subsequently, a system was developed for use in the field of chemistry. The success of this system led to the initiation of scientific research, which in turn resulted in the development of numerous other systems that were subsequently applied in the field of medicine (Grabarek, Stasiak-Cieślak, 2019). Expert systems are limited to a specific discipline. In this way, they are regarded as a form of traditional artificial intelligence, although they do not learn by constructing comprehensive models; instead, they draw on a database that has been encoded by humans (Arias, 2022). Expert systems represent one of the earliest tools to be employed in practice. By design, this system is intended to replace the expert in solving more complex tasks and problems. By recording the knowledge of experts in a specific field, the system can access and apply it repeatedly (Wyskwarski, 2015).

An artificial neural network (ANN) can be defined as a biologically inspired computational model comprising processing elements (referred to as neurons) and connections with coefficients. These connections constitute the neuronal structure to which the learning and recall algorithms are attached. In simple terms, artificial neural networks are a collection of mathematical techniques used for signal processing, prediction and clustering (Shanmuganathan, 2016). Their structure is modelled on the human brain, and their approach to problem solving and structure itself resembles the operation of the nervous system (Wyskwarski, 2015). However, the human brain is much more complex and many of its cognitive functions remain to be discovered (Shanmuganathan, 2016).

Another part of artificial intelligence, considered a subset of it, is machine learning. It consists of teaching machines the given rules according to which they should act, and then using them to solve a problem. The model that is prepared is intended to enable a decision to be made or a phenomenon to be predicted based on the analysis of data that was previously provided in the learning phase. This data is called training data and is fundamental to the final creation of the model. It is also crucial to select an appropriate algorithm responsible for carrying out the learning process (Młodzianowski, Rostowski, 2021). There are three variants

of machine learning based on the method of learning - supervised, unsupervised and reinforcement learning (Morales, Escalante, 2022).

A review of the literature indicates that artificial intelligence is being implemented in the manufacturing sector at multiple levels, including optimization of the production process, collaboration between humans and robots, and resolution of maintenance issues (Arinez et al., 2020).

One example of the application of artificial intelligence is the machine learning model presented by researchers Hrnjica and Softic, which is used in the field of predictive maintenance. Machine learning was used to develop a model for predicting the failure of production machine components/parts. The model created in the study achieved high prediction accuracy (99% in test data), suggesting that AI can make a significant contribution to reducing the costs associated with unplanned downtime, failures and precent the occurrence of machine errors (Hrnjica, Softic, 2022).

Another area of industrial application for artificial intelligence is quality assurance. Today, there are a number of solutions for achieving high product quality through the use of highly automated production machines (Arora, Gupta, 2022). In the context of quality assurance in manufacturing, process automation is becoming a crucial component of industrial strategies. The utilization of artificial intelligence, particularly machine learning algorithms, not only facilitates the expeditious and precise identification of defects, but also the implementation of real-time monitoring systems. The utilization of models such as convolutional neural networks (CNNs) enables the automatic identification of undesirable phenomena, thereby markedly enhancing the quality of the final product. The implementation of such solutions facilitates an immediate response to detected irregularities, which can result in time and resource savings, as well as increased production efficiency (Patel et al., 2019; Schreiber et al., 2019).

In the field of manufacturing, collaborative robots (cobots) are also being deployed. Over the past decade, research into human-machine relationships has concentrated on the intricacies of collaboration, in which cobots must not only avoid collisions but also respond adaptively to circumstances and communicate in a manner that is analogous to that of humans (Faccio, Cohen, 2024). Cobots are being applied in a diverse range of industries, reflecting their versatility and high level of accuracy. Their ability to perform tasks requiring precision and to handle hazardous substances without risk to human operators makes them an attractive option in many workplaces. The potential benefits of cobots, particularly in terms of enhanced safety, flexibility and improved efficiency, are frequently highlighted (Javaid et al., 2022).

Furthermore, artificial intelligence can be employed not only in the operational activities of manufacturing businesses but also in planning and strategic decision-making. In particular, it can be utilized in forecasting consumer demand (Aktepe et al., 2021). In general, a multitude of demand forecasting techniques are based on artificial intelligence (Mediavilla, Dietrich, Palm, 2022), in certain cases, these techniques are combined with additional approaches that extend the conventional boundaries of artificial intelligence. For instance, examples include

hybrids of AI and metaheuristic algorithms (Goli et al., 2018). The use of artificial intelligence algorithms makes it possible to analyze huge amounts of data, leading to more accurate demand forecasts. These models can identify hidden patterns and changes in consumer behavior that traditional statistical methods may miss. This can lead to increased operational efficiency and reduced costs associated with running the business (Kondapaka, 2021). In addition to the previously mentioned applications, artificial intelligence can also be utilized to develop innovations that may prove to be of considerable importance in the field of manufacturing (Szymańska, Berbel Pineda, 2024).

The integration of artificial intelligence (AI) into manufacturing represents a comprehensive strategy for advancing product efficiency, operational effectiveness, and safety standards. Through the optimization of production processes, the efficient allocation of resources, and the implementation of sophisticated quality assurance methodologies, AI enables substantial improvements in overall operational performance. Within the domain of skills analysis related to manufacturing processes, the adoption of AI assumes a critical role. This technology facilitates a proactive framework for workforce development by systematically analyzing historical data, identifying recurring patterns, and forecasting future skill demands. Consequently, it ensures the identification and cultivation of essential competencies necessary for sustaining industry advancements (Doanh et al., 2023).

3. Methodology

The methodology used in this study was based on a systematic review of the literature. This approach has been described in a number of papers (Okoli, 2015; Xiao, Watson, 2019). A large number of scientific papers based on a systematic review of the literature have shown that this is a method that gives satisfactory results (Halicka, 2017; Szum, 2021; Kozłowska, 2022; Szpilko et al., 2023). The study carried out for this publication was divided into five phases. The whole, and the order in which it was carried out, is shown in Figure 1.

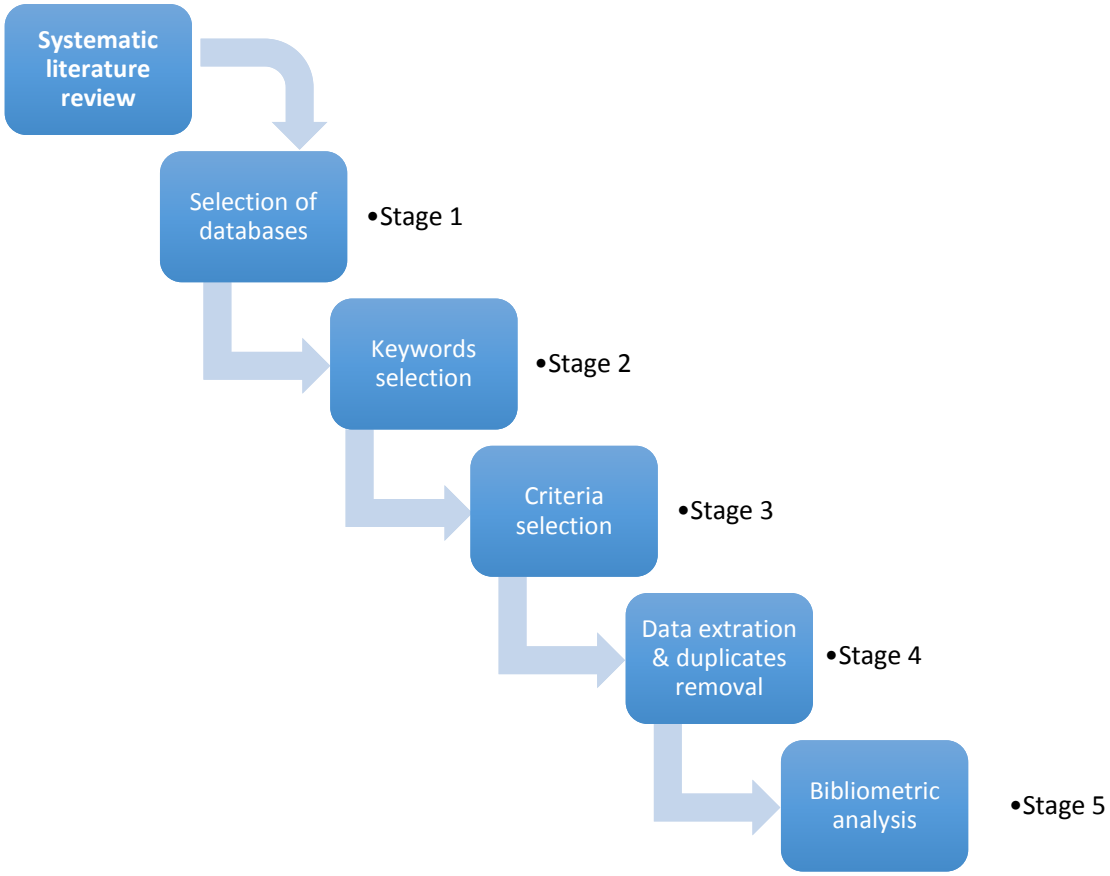

Figure 1. Methodology of the literature review carried out.

Source: author's own elaboration.

The initial stage of the process entailed the identification of pertinent scientific databases that align with the subject matter of the study. This involved the critical assessment of sources that exhibited a high degree of quality and relevance. The databases ultimately selected for the study were Web of Science and Scopus. In the second step, however, a set of keywords was developed to enable literature searches. The keywords were chosen to reflect the theme of the study as closely as possible. The next step was to establish inclusion criteria. It was determined which publications would be included in the analysis. In this study, items published from the beginning of 2015 to the end of October 2024 were included. In addition, the language of publication - English - was a factor in the criteria. For document types, the following were considered: articles, conference papers, book chapters, reviews, editorial materials, books and short surveys. At this stage, papers that did not meet the specified conditions were excluded. Once the results were collected, a data extraction process was carried out, which involved extracting key information from the publications (e.g. authors, titles, citations). Duplicates were then removed to ensure the data set was unique. The criteria used to identify duplicate papers were document characteristics such as DOI, titles and authors. The final stage involved conducting a bibliometric analysis that identified research trends, the most cited papers, key countries and authors and other relevant aspects of the literature. This analysis provided valuable information on the structure of the study area.

Table 1.
Research results

Step	Databases	
	Web Of Science	**Scopus**
	First search	
Research query #1	(TS=(ai) OR TS=(artificial intelligence)) AND (TS=(manufacturing) OR TS=(production))	TITLE-ABS-KEY ("ai" OR "artificial intelligence") AND TITLE-ABS-KEY ("manufacturing" OR "production")
Number of results without inclusion criteria	19,744	41,800
Number of results with inclusion criteria	15,107	29,414
	Second search	
Research query #2	(TI=(ai) OR TI=(artificial intelligence)) AND (TI=(manufacturing) OR TI=(production))	TITLE ("ai" OR "artificial intelligence") AND TITLE ("manufacturing" OR "production")
Number of results without inclusion criteria	1,038	1,790
Number of results with inclusion criteria	770	1,370
Unique items	1,451	

Source: author's own elaboration.

The initial search was conducted using the document's title, abstract, and keywords as search terms. However, as the first search yielded several thousand results and the inclusion criteria were applied, only the title was considered in the second search. Documents containing the terms "AI" or "artificial intelligence" and "manufacturing" or "production" in the title were subjected to examination. This yielded 1,038 results from the Web of Science database and 1,790 from the Scopus database prior to the application of the inclusion criteria. Following the application of the inclusion criteria, 770 and 1,370 documents were obtained, respectively. After the removal of duplicate items, the final result was 1,451 items.

4. Results

Based on the unique results extracted from both databases (1451 positions), a summary showing the breakdown of items by document type was developed. The results are presented in Figure 2.

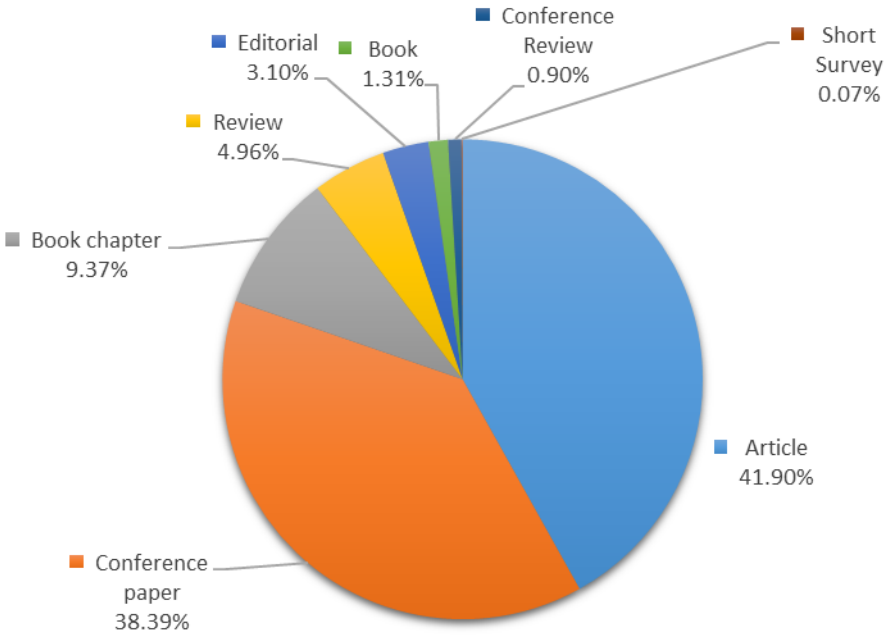

Figure 2. Documents by type.

Source: author's own elaboration.

The two most numerous categories account for more than 80% of all results. The most frequently occurring type of work was the article, while the second most common was the conference paper. Book chapters accounted for almost 10% of all results, while the remaining items reached values of 5% or less. This means that, in the field under study, the publication of results in the form of articles and conference papers is the most popular way of scientific communication. Book publications and niche forms (e.g. conference reviews and short surveys) are of secondary importance, indicating the dynamic nature of knowledge and the preference for quick sharing of research results in the form of scientific articles. Additionally, the results highlight the importance of conferences in the field of artificial intelligence.

The following stage in the bibliometric analysis was to provide a summary of the distribution of papers in terms of the years in which they were published. The results are presented in Figure 3.

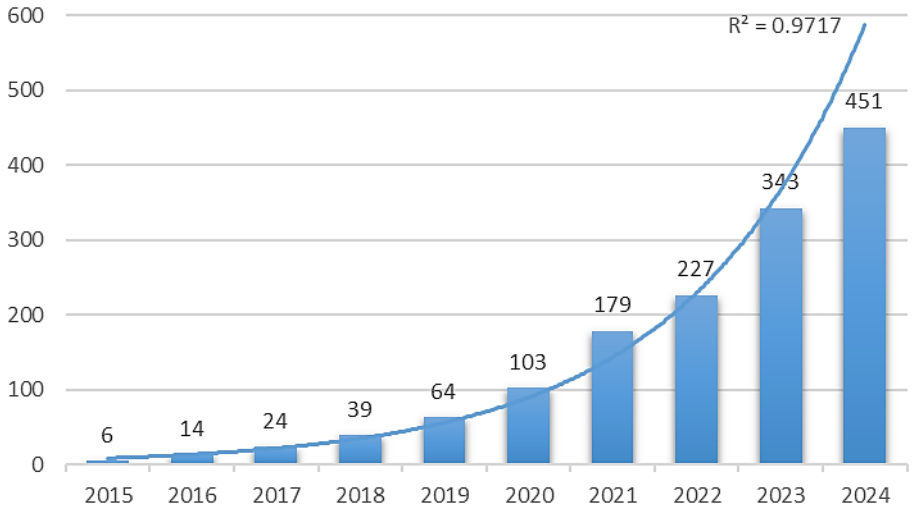

Figure 3. Documents by publication year.

Source: author's own elaboration.

As illustrated in the figure, the number of publications is increasing in a dynamic manner. It is important to note that the data for 2024 represents a period from January to the end of October. This indicates that the total number of publications is likely to increase by the end of the year. The figure uses an exponential trend line, for which an R^2 value equal 0.9717 was calculated. The high degree of coefficient of determination confirms that the number of publications is growing exponentially. The rate of growth accelerated significantly following 2019. From 2015 to 2019, the number of publications increased from 6 to 64. In contrast, the number of publications increased from 64 to 451 between 2020 and 2024. This represents a significant expansion in the volume of published work, particularly when viewed in the context of the exponential rate that became more apparent after 2020. The increase in the number of publications reflects the intensification of research activities and the growing importance of the field in the scientific community.

The third element of the study was to summarize the data collected in terms of the most productive countries, organizations and authors. The results are presented in Table 2.

Table 2.
Research results in terms of most productive countries, organizations and authors

No.	Item	NP	%	Average citation count
Most productive countries				
1	China	262	18.06	8.45
2	United States	242	16.68	11.70
3	India	194	13.37	3.97
4	Germany	161	11.10	5.27
5	United Kingdom	95	6.55	11.12
6	Italy	73	5.03	6.40
7	Spain	42	2.89	2.83
8	South Korea	40	2.76	4.83
9	France	39	2.69	14.10
10	Canada	35	2.41	2.63

Cont. table 2.

Most productive organizations				
1	Fraunhofer Gesellschaft	17	1.17	7.06
2	Polytechnic University of Milan	17	1.17	2.65
3	University of Johannesburg	15	1.03	28.67
4	University of Patras	13	0.90	15.46
5	RWTH Aachen University	12	0.83	11.92
6	Technical University of Munich	11	0.76	2.00
7	Indian Institute of Technology System	10	0.69	40.90
8	Helmholtz Association	10	0.69	6.90
9	University System of Ohio	9	0.62	32.22
10	University System of Georgia	9	0.62	4.33
Most productive authors				
1	Alexopoulos K	7	0.48	20.57
2	Wang Y	6	0.41	5.33
3	Chryssolouris G	5	0.34	28.20
4	Qian F	5	0.34	21.40
5	Kumar A	5	0.34	18.60
6	Wagner J	5	0.34	16.00
6	Burggräf P	5	0.34	16.00
8	Arkouli Z	5	0.34	11.00
9	Lee J	4	0.28	136.50
10	Liu J	4	0.28	68.00

Note. NP – number of publications; % - percentage share of the data set (1451 results); the sorting in the ranking was adopted according to the following criteria: (1) number of publications, (2) average number of citations

Source: author's own elaboration.

The two countries with the highest number of publications are China (262) and the United States (242). In terms of the average number of citations, the US is the favorite of the two, as it has 11.70 citations per publication, while China has 8.45. This may indicate the greater scientific influence of the US compared to China. India ranked third with a high number of citations (194), but a relatively low average number of citations per publication (3.97).

In examining the most productive organizations, it is notable that the first two positions are occupied by European centers with an identical number of publications, 17. However, the average number of citations for the Fraunhofer Gesellschaft is higher, at 7.06. For the Polytechnic University of Milan, the ratio is 2.65 citations per publication. In third place is the University of Johannesburg with 15 publications and an average number of citations of 28.67.

In terms of authors with the highest number of citations, Alexopoulos K is in the leading position with 7 publications and a citation average index for these publications of 20.57. The next most cited author is Wang Y with 6 publications and a citation average of 5.33. The third most cited author is Chryssolouris G with 5 publications and a citation average of 28.20.

This compilation provides an overview of the global dynamics of research and its impact, organized by country, institution and academia, as well as by author. China and the United States lead in terms of the number of publications, but publications from the United States, the United Kingdom, and France are more influential, which may indicate that they represent

higher quality research. While India and certain European countries (e.g., Italy, Spain) make notable quantitative contributions, the average number of citations suggests a more limited scope of influence. It is evident that developing countries (e.g., India) and less well-known institutions have the potential to enhance the impact of their research. One strategy may be to establish global networks.

The next stage in bibliometric analysis was performance of keywords co-occurrence in given dataset. A thesaurus file was also created to guarantee correctness and relevance of analyzed keywords dataset. This was done in order to exclude terms that were not related to the study (such as article, case study) or duplicate terms with similar meanings (such as artificial intelligence and AI). Keyword analysis and an examination of the publication collection served as the foundation for the creation of this file. The analysis's findings made it possible to identify thematic clusters that reflect the primary and new areas of investigation. The results are presented in Figure 4.

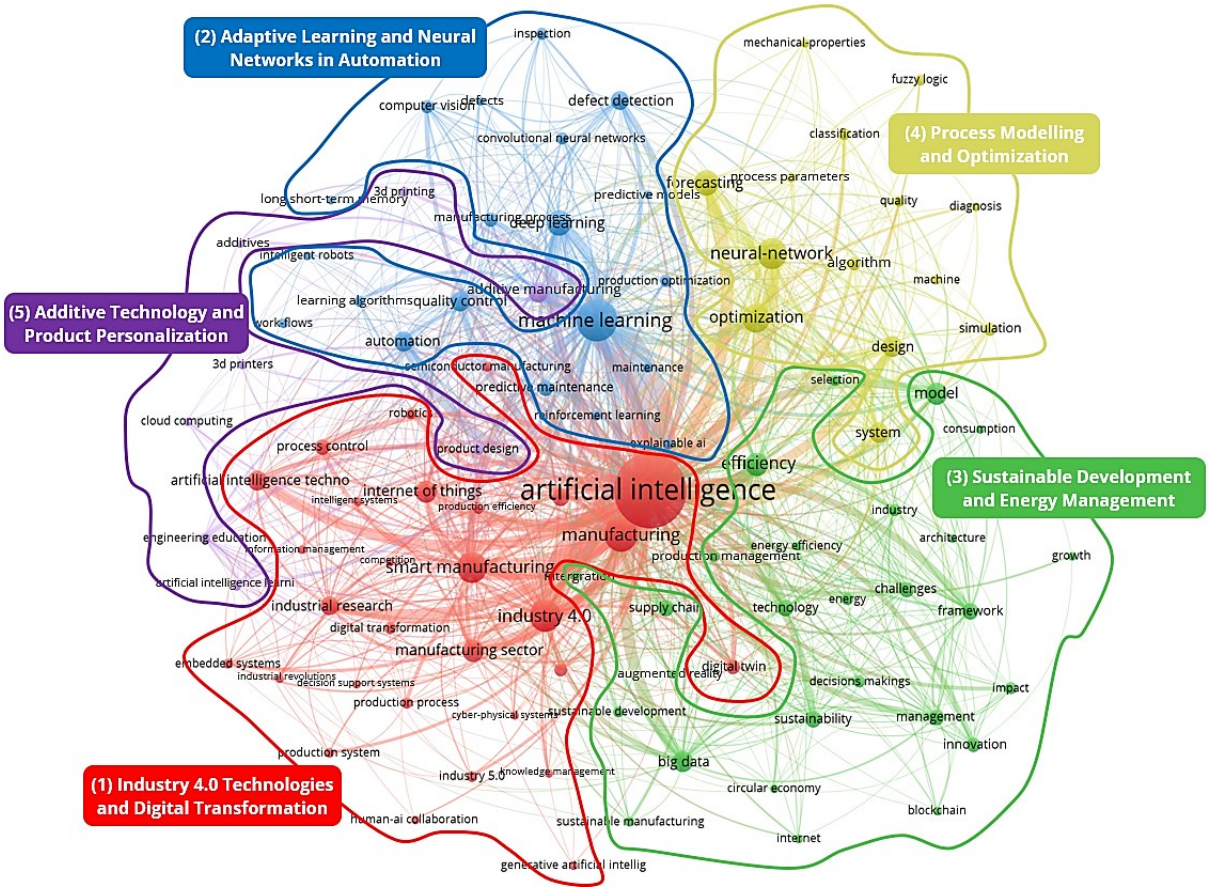

Figure 4. Keywords co-occurrence for artificial intelligence in manufacturing divided into thematic clusters.

Source: author's own elaboration using VOSviewer software.

5. Discussion

First cluster, the biggest one, entitled "Industry 4.0 Technologies and Digital Transformation", concentrates on the function of Industry 4.0 in the digital transformation of the manufacturing sector. The central node is the concept of "artificial intelligence" (730 occurrences) which encompasses a vast array of applications. Additionally, pivotal topics such as "manufacturing" (157), "smart manufacturing" (128) and "internet of things" (65) are of significance in this cluster. These concepts underscore the advanced interconnectivity between devices and systems, resulting in enhanced manufacturing processes and efficiency. The concept of "Industry 4.0" (131) represents a significant aspect of this cluster, reflecting a general tendency towards the integration of intelligent technologies in industrial processes. This includes the utilization of advanced concepts such as "digital twin" (30) and "cyber-physical systems" (10). Additionally, terms like "decision making" (43) and "data analytics" (26) highlight the growing importance of data-driven decision-making and analytics based on advanced algorithms.

The second cluster, which is entitled "Adaptive Learning and Neural Networks in Automation", is concerned with the deployment of innovative artificial intelligence approaches in the context of industrial process automation. At the core of this cluster are technologies such as "machine learning" (234) and its subset "deep learning" (86), which facilitate adaptive and intelligent decision-making in high-complexity industrial settings. One of the central themes of this cluster is the concept of "automation" (53) and the related processes of "defect detection" (48) and "quality control" (60). Additionally, the cluster demonstrates an interest in areas such as "computer vision" (25) and "predictive maintenance" (33), which have the potential to enhance the operational profitability of companies. The use of terms such as "reinforcement learning" (15) and "learning algorithms" (16) indicates that these systems are becoming increasingly autonomous and capable of learning from experience, leading to further optimization and automation.

Cluster three, designated as "Sustainable Development and Energy Management", is concerned with matters related to energy efficiency, resource management, and the implementation of sustainable strategies in industry. In addition to concepts such as "model" (62), "big data" (59), and "supply chain" (39), issues such as "sustainability" (35), "energy" (20), and the more narrowly defined "sustainable manufacturing" (17) were included. The theme of "efficiency" (20) is a key focus of the cluster, indicating that the objective is to achieve the highest possible operational efficiency while reducing energy and resource consumption. However, the phrase "challenges" (32) suggests an attempt to address the sustainability challenges of modern industry under the broader concept of "sustainable development" (17) through the use of diverse technological solutions, which are outlined under the theme "technology" (37).

The fourth cluster, named “Process Modelling and Optimization”, focuses on the modelling of industrial processes, their optimization and the application of advanced analytical techniques and technologies, such as neural networks, to improve the quality, efficiency and precision of production. An analysis of the keyword weights in this cluster makes it possible to distinguish dominant themes such as “optimization” (106), “simulation” (25), “system” (53) and “process parameters” (13). This indicates that the main objective of the cluster is to improve industrial processes through detailed modelling and optimization. On the purely technical side, keywords such as “neural-network” (125) and “algorithm” (23) pointed out, highlighting the use of neural networks for prediction and analysis of process data. This is supported by technologies related to “forecasting” (87), which enables the prediction of future problems and risk management, which is invaluable in production planning. Topic “design” (60), on the other hand, indicates the design of optimized production systems.

The final cluster, “Additive Technology and Product Personalization”, is the least significant in terms of importance and focuses on the utilization of additive technologies and product customization, reflecting the most recent trends in industrial personalized manufacturing. The cluster is defined by two key terms: "additive manufacturing" (52) and “additives” (25). These indicate the dominance of "3D printing" (15) technology and methods related to the creation of layer-by-layer structures. These technologies facilitate the production of highly complex shapes while reducing the amount of waste and materials needed for production. It was therefore unsurprising that the term “3D printers” featured prominently. The concept of “product design” (24) is also pivotal in this process, facilitating the creation of customized solutions that align with the specific requirements of the end user. The importance of “engineering education” (18) in equipping professionals with the requisite knowledge and expertise to utilize these technologies on a large scale is also highlighted.

The co-occurrence analysis made it possible to identify five thematic clusters that constituted research subareas in the context of AI in manufacturing. In Table main research subareas and main research issues of each cluster are presented.

Table 3.
Research subareas and main research issues in AI in manufacturing

No.	Cluster name	Research subareas	Main research issues
1.	Industry 4.0 Technologies and Digital Transformation	cyber physical systems, IoT, digital twins	- Integration of IoT technology and cyber-physical systems with AI (Ahmmed, Isanaka, Liou, 2024; Moosavi et al., 2024; Trakadas et al., 2020) - Development of digital twins for industrial process modeling and monitoring using AI (Pracucci, 2024; Urgo, Terkaj, Simonetti, 2024; Vyskočil et al., 2023) - Decision-making based on advanced artificial intelligence algorithms (Castañé et al., 2023; Patalas-Maliszewska, Pająk, Skrzeszewska, 2020; Franke, Franke, Riedel, 2022)

Cont. table 3.

2.	Adaptive Learning and Neural Networks in Automation	process automation, quality control, predictive maintenance	- Implementing machine learning algorithms for defect detection and process optimization (Chauhan, 2023; Leberruyer et al., 2023; Getachew et al., 2024, Rezaei et al., 2023) - Using neural networks to predict process behavior (Obaidullah, 2023; Rathore et al., 2023; Baskar et al., 2024) - Predictive maintenance of machinery and equipment using AI (Netisopakul, Phumee, 2022; Rossini et al., 2021; Liu et al., 2022, Hrnjica, Softic, 2020)
3.	Sustainable Development and Energy Management	energy efficiency, sustainable manufacturing strategies	- Optimize industrial energy and resource consumption with AI (Shi et al., 2023; Akinadewo et al., 2024; Lamsaf et al., 2024) - Implementing sustainability strategies in manufacturing based on AI technologies (Rojek et al., 2024; Wang, Wen, Long, 2024; Agrawal et al., 2023) - Life cycle analysis of products in the context of AI-supported sustainable manufacturing (Andres et al., 2023; Mirzaei et al., 2023; Kaab et al., 2019)
4.	Process Modelling and Optimization	process modeling, forecasting, systems projecting	- Simulation and optimization of production processes using AI (Baskar et al., 2024; Stavropoulos, Papacharalampopoulos, Christopoulos, 2023; Jadhav et al., 2024; Rentsch, Heinzel, Brinksmeier, 2015) - Development of prediction algorithms for better risk management in industrial processes (Mmbando, 2024; Umer, Belay, Gouveia, 2024; Radanliev, De Roure, 2023; Massaro et al., 2021)
5.	Additive Technology and Product Personalization	3D printing, product design, additive technologies	- Optimization of 3D printing parameters using AI algorithms to reduce defects and increase quality (Abbili, 2024; Ulkir, Bayrakilar, Kuncan, 2024; Amini, Chang, Rao, 2019) - Product design using AI (Wan et al., 2020; Singh, Singh, Soni, 2024; Liu, Tian, Kan, 2022; Aphirakmethawong, Yang, Mehnen, 2022)

Source: author's own elaboration.

The analysis of Table 3 in the context of artificial intelligence (AI) applications in manufacturing reveals an intricate interplay between thematic research clusters, key technological advancements, and emerging trends. Five thematic clusters were identified, each highlighting distinct aspects of AI's role in transforming manufacturing processes and strategies. These clusters—Industry 4.0 Technologies and Digital Transformation, Adaptive Learning and Neural Networks in Automation, Sustainable Development and Energy Management, Process Modelling and Optimization, and Additive Technology and Product Personalization—serve as focal points for understanding the multifaceted impact of AI in manufacturing.

Industry 4.0 Technologies and Digital Transformation is the most prominent cluster, underscoring the critical role of integrating IoT, digital twins, and cyber-physical systems with AI to enhance decision-making and operational efficiency. Research within this cluster highlights the sophistication of AI-driven data analytics and the centrality of real-time process monitoring. The development of digital twins, as evidenced by the literature, has enabled predictive analytics and proactive decision-making, emphasizing AI's transformative potential in achieving seamless digitalization.

The Adaptive Learning and Neural Networks in Automation cluster focuses on AI's capability to automate quality control, optimize defect detection, and predict maintenance requirements. With technologies like machine learning and deep learning, AI applications have shifted from reactive to predictive, ensuring operational efficiency and minimizing downtime. This cluster illustrates the increasing autonomy of AI systems and their ability to learn from data for continuous process improvement.

Sustainable Development and Energy Management has emerged as a pivotal area, addressing the dual challenge of efficiency and sustainability in manufacturing. AI's integration with energy management systems demonstrates its ability to dynamically optimize resource use and reduce carbon footprints. Research here also highlights AI's contribution to life cycle analysis and the adoption of sustainable practices in manufacturing strategies, aligning with global sustainability goals.

The Process Modelling and Optimization cluster demonstrates AI's role in refining manufacturing processes through simulation, forecasting, and risk management. The use of neural networks and optimization algorithms has proven effective in identifying inefficiencies and proactively addressing production challenges. This thematic area underscores the importance of precise modeling for achieving operational excellence.

Finally, Additive Technology and Product Personalization represents the cutting-edge of manufacturing innovation. AI's application in 3D printing and product customization signifies a paradigm shift towards individualized manufacturing solutions. By leveraging advanced machine learning algorithms, manufacturers can design products tailored to specific consumer needs while maintaining high quality and efficiency. This cluster also highlights the educational implications of equipping professionals with the knowledge to harness these emerging technologies.

The identified clusters collectively illustrate the breadth of AI applications in manufacturing and its potential to redefine industrial paradigms. However, challenges remain, such as the need for seamless technology integration, addressing ethical considerations, and bridging the gap between theoretical research and practical implementation.

The research conducted enabled quantitative analysis of the results obtained, which allowed a detailed examination of trends in the literature and the main directions of ongoing research. As a result of the analysis, five thematic clusters were identified, which reflect the key areas of scientific interest in the field. At the same time, the overall popularity of each cluster was shown, which allows a better understanding of the distribution of research priorities in the overall literature on artificial intelligence in manufacturing.

To answer the question of how artificial intelligence affects Industry 4.0, one must first explore the field of "industrial artificial intelligence". The field of industrial AI is concerned with the application of AI in industrial contexts, including manufacturing, logistics, and supply chain management. The objective is to optimize industrial processes, enhance operational efficiency, and improve product quality (Lee et al., 2018). While this concept has been

discussed in the literature, it is important to consider the role of "traditional" AI in industry. This issue is addressed by the present work.

In the context of adaptive learning in their work, authors Kumar, Dimitrakopoulos, and Maulen, approach the topic of production planning in an innovative way, combining various digital techniques and machine learning algorithms. Their work emphasizes the importance of integrating sensor-generated data with traditional sources of information, and points to the need to constantly update production decisions in response to changing operational conditions (Kumar, Dimitrakopoulos, Maulen, 2020).

Analysis of the results indicates that sustainability and energy management have become key topics in research on the application of artificial intelligence in industry. A separate thematic cluster highlights how technologies such as artificial neural networks, optimization systems, and predictive algorithms are being used to efficiently manage resources, reduce energy consumption, and minimize the environmental impact of manufacturing operations. Contemporary research often emphasizes the integration of AI with energy management systems to dynamically adjust production processes to the availability of energy from renewable sources, while reducing greenhouse gas emissions (Vinuesa et al., 2020).

The application of modelling processes to improve existing processes is not a recently observed trend. These processes continue to play a pivotal role in modern manufacturing, enabling the increase in efficiency, reduction in costs, and improvement in product quality. As evidenced in the literature, applications of this nature include the prediction of system behavior based on input variables, thereby facilitating the expedient identification of potential issues and the subsequent pursuit of solutions. In particular, techniques such as simulations based on machine learning algorithms allow for the testing of multiple scenarios in a virtual environment before implementation in the physical world. Successful AI implementations in industry have been shown to result in significant operational improvements and cost savings. Case studies illustrate the effectiveness of AI technology in real-world manufacturing scenarios, which provide valuable guidance for other manufacturers looking to begin implementing AI in production optimization (Kasaraneni, 2021).

The research has identified a significant role for additive technologies and product personalization in modern industry, as evidenced by a separate thematic cluster. The personalization of products, supported by advanced machine learning algorithms and neural networks, plays a particularly important role in sectors that require a high degree of product customization in order to meet specific customer requirements. The literature indicates that artificial intelligence makes it possible to analyze consumers' preferences in order to dynamically design products tailored to their expectations. Furthermore, artificial intelligence is used in three key stages of product development: design, manufacturing, and evaluation (Liu, Tian, Kan, 2022).

6. Conclusions

The research conducted, based on a systematic literature review, provided a comprehensive picture of the rapidly growing field of artificial intelligence (AI) application in the manufacturing industry. Bibliometric analysis showed a significant increase in the number of publications in recent years, especially after 2019, reflecting the intensification of scientific interest and the growing importance of AI in the context of industrial transformation.

The most productive countries in this field are China and the United States, which dominate in terms of the number of publications. However, the higher average number of citations of US publications indicates their greater scientific influence. The analysis of leading authors and institutions showed considerable diversity in terms of their influence on the development of the study area. The results indicate that both prestigious research institutions and individual scientists play an important role in building knowledge and shaping global trends in this rapidly developing field.

The findings of this study also highlight the transformative role of artificial intelligence (AI) in the manufacturing sector, driven by rapid advancements in technology and a growing demand for innovation.

AI's impact is reflected across five key thematic clusters, showcasing its diverse applications. From enabling digital transformation through Industry 4.0 technologies to advancing process optimization and sustainable energy management, AI has proven indispensable in addressing contemporary challenges. Notably, the adoption of adaptive learning systems and additive manufacturing underscores AI's ability to enhance both operational efficiency and product customization.

The study underscores the importance of sustainability as a focal point, with AI-driven strategies significantly contributing to energy efficiency and reduced environmental impact. These findings align with global priorities for sustainable industrial practices and highlight the potential of AI to shape an environmentally conscious future for manufacturing.

However, significant challenges persist, including barriers to widespread implementation, economic feasibility, and technological readiness. Bridging the gap between academic research and industrial applications requires targeted efforts to overcome these obstacles. Collaborative research initiatives, policy support, and investment in workforce education will be critical to maximizing the benefits of AI in manufacturing.

In conclusion, AI represents a cornerstone of modern manufacturing innovation. Its ability to drive efficiency, foster sustainability, and deliver personalized solutions positions it as a transformative force in the industry. Continued exploration of its potential and proactive measures to address existing challenges will ensure that AI fulfills its promise as a catalyst for the next industrial revolution.

Future research can focus on analyzing the extent to which scientific findings presented in the literature are reflected in practical implementations in actual manufacturing processes. For example, while additive manufacturing technologies and optimization algorithms are widely explored in scientific publications, it is necessary to investigate whether and to what extent their theoretical potential translates into successful applications in industrial practice. Such research will allow the identification of technological, organizational or economic barriers to the implementation of innovative solutions, as well as the development of strategies to accelerate the transfer of knowledge from the field of research to actual production.

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