a scientific open access quarterly

International Entrepreneurship Review

ISSN 2658-1841

2025, vol. 11, no. 3

KRAKOW UNIVERSITY OF ECONOMICS
Department of International Trade
Centre for Strategic and International Entrepreneurship

a scientific open access quarterly

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ISSN 2658-1841 2025, Vol. 11, No. 3

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Publisher

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Copyediting: Anna Marcinek-Markowska
Proofreading: Marek Maciejewski, Elżbieta Bombińska
Cover and DTP: Marek Sieja

Reviewers

All articles are double-blinded peer-reviewed at least by two independent reviewers.
The detailed list of reviewers is published at our website once a year.

Original Version

The online journal version has been the only one since 2019.
The online journal is the primary and reference version.

ISSN 2658-1841 (since 2019)
ISSN 2543-537X, eISSN 2543-4934 (in the years 2015-2018)

Abstracting/Indexing

The journal, and all its articles, is abstracting and/or indexing
in international databases, including:

DOAJ (England, UK)
Sherpa Romeo (England, UK)
ERIH Plus (Norway)
Publons (Beijing, China)
ProQuest (USA)
EBSCO (USA)
Google Scholar (USA)
EconPapers – RePEc (Sweden)
Crossref (USA)
BazEkon (Poland)
BazHum (Poland)
Index Copernicus (Poland)
ROAD (USA)
WorldCat (Netherlands)

Identification and Originality

All articles published in IER are tagged with an identification number
employing the Digital Object Identifier (DOI) System.
IER uses the Crossref Similarity Check service powered by iThenticate to verify the originality of articles
submitted to the journal.

Table of Contents

Empirical insights into the reduction of operational costs through AI: A study of Jordanian companies **7**
Sulaiman Weshah

The counterparty credit risk appetite in the Polish over-the-counter derivatives market **17**
Piotr Wybieralski

A complex phenomenon of students' entrepreneurial poten-tial **29**
Sarp Güneri, Michalina Mróz, Hakkı Polat, Tomasz Skica

Analysis of the circular management model of information and communication technology resources of large enterprises in the European Union **65**
Małgorzata Sztorc, Konstantins Savenkovs

A thirty-year evolution of enterprise resilience research: A scoping review **93**
Sylwia Bąk

Managerial psychological gender and its impact on selected corporate behaviours **133**
Wojciech Popczyk, Alicja Winnicka-Popczyk, Zaklina Jablonska

Greenhorns or old stagers: Is equity crowdfunding in Poland inclusive? **161**
Dominika Kordela, Mariusz Kicia

Barriers to the foreign expansion of small and medium enterprises: Example of Subcarpathian exporters **179**
Katarzyna Puchalska, Agnieszka Majka, Patrycja Żegleń

Globalisation and human development: Long-term evidence from countries at different levels of development **193**
Dorota Kuder, Justyna Wróblewska

International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.01

Empirical insights into the reduction of operational costs through AI: A study of Jordanian companies

Sulaiman Weshah

ABSTRACT

Objective: I investigated how artificial intelligence (AI) tools can help reduce operational costs in businesses across Jordan. I examined the specific ways AI enhances efficiency and optimises resource utilisation, ultimately impacting financial outcomes.

Research Design & Methods: I utilised a qualitative research approach, employing a systematic literature review and thematic analysis to examine how AI contributes to reducing operational costs. The review consolidates findings from academic and industry sources to identify key trends. I performed thematic analysis to extract insights on AI-driven automation, cost efficiency strategies, and the challenges associated with implementation. The study does not involve primary data collection or empirical case studies. The study offers recommendations to assist businesses in optimising AI adoption.

Findings: Study identified key themes on how AI reduces operational costs, Key cost-saving mechanisms include automation, predictive analytics, and resource optimisation. Sectors like manufacturing, finance, and telecommunications reduce operational costs by cutting labour costs, improving decisions, and increasing efficiency. Challenges include high costs, training gaps, and implementation risks. One must address them to ensure successful AI adoption. Findings are based on literature analysis, and not on primary data.

Implications & Recommendations: The research emphasised the need for Jordanian companies to adopt AI to remain competitive and boost profitability. Businesses should invest in AI training to upskill their workforce. AI requires integrating in areas with clear, measurable benefits. Partnering with AI firms can help streamline adoption and integration.

Contribution & Value Added: This study presents a structured analysis of AI-driven cost reduction, highlighting how automation, predictive analytics, and supply chain optimisation enhance operational efficiency. Unlike broader studies on AI adoption, I specifically examined cost-saving mechanisms within Jordanian businesses, tackling challenges such as high initial investment costs and workforce skill gaps. The study offers practical recommendations for businesses and policymakers, contributing to the wider discussion on AI's role in digital transformation and financial sustainability.

Article type:	research article
Keywords:	artificial intelligence (AI); cost reduction; operational costs; digital transformation; Jordanian companies
JEL codes:	M0, M4, O3

Received: 7 June 2024 | Revised: 29 April 2025 | Accepted: 4 May 2025

Suggested citation:
Weshah, S. (2025). Empirical insights into the reduction of operational costs through AI: A study of Jordanian companies. *International Entrepreneurship Review,* 11(3), 7-16. https://doi.org/10.15678/IER.2025.1103.01

INTRODUCTION

Artificial intelligence (AI) is revolutionising business operations by providing organisations with innovative tools to optimise processes, minimise errors, and boost efficiency. Among its most significant contributions is the reduction of operational costs, where automation and data-driven decision-making allow businesses to streamline workflows and enhance productivity. Operational costs – encompassing labour, energy, and resource management – are a major portion of a company's overall

expenses. Therefore, leveraging AI-driven solutions to cut these costs presents a substantial opportunity for businesses to maintain a competitive edge.

Artificial intelligence (AI) has penetrated various industries and proved to be useful in fulfilling various organisational requirements (Tariq *et al.*, 2021). The utilisation of advanced AI technologies by companies not only reduces operational costs but also brings about digital transformation (Drydakis, 2022). Companies are now deploying AI and predicting a huge impact concerning organisational performance (Dzhusupova *et al.*, 2023).

Study Objective

I sought to investigate how AI can lower operational costs in Jordanian businesses by pinpointing the specific mechanisms through which AI improves efficiency and optimises resource use. While cost reduction often correlates with improved profitability, I focused exclusively on the impact of AI-driven efficiencies on cost structures rather than broader financial performance metrics.

Research Questions

1. In what ways do AI applications help reduce operational costs for businesses in Jordan?
2. What are the primary challenges and opportunities Jordanian companies encounter when integrating AI into their operations?
3. What strategic recommendations can be offered to businesses aiming to implement AI for cost reduction purposes?

Novelty and Theoretical Context

Although there is an expanding body of research on AI's role in business operations, there is limited focus on its specific impact on reducing operational costs within Jordanian enterprises. This study addresses this gap by analysing real-world examples and proposing actionable strategies for AI adoption. Moreover, the research is situated within the wider framework of digital transformation, where AI acts as a pivotal enabler for modernising business processes. Digital transformation goes beyond mere automation; it involves reengineering operations, harnessing data analytics, and incorporating intelligent technologies to achieve greater efficiency. By embedding AI into this transformative process, companies can achieve sustainable improvements in their operations.

This research not only fills a critical knowledge gap but also provides practical insights for Jordanian businesses seeking to implement AI-driven cost reduction strategies effectively.

This research begins by introducing the significance of artificial intelligence (AI) in reducing operational costs, particularly in the context of Jordanian companies. It then outlines the research objectives and questions, followed by a literature review that synthesizes current academic and industry findings on AI implementation, cost efficiency, and associated challenges. The methodology section explains the qualitative research design based on systematic literature review and thematic analysis. Subsequently, the results and discussion section presents thematic findings on AI-driven cost-saving mechanisms and implementation barriers. The article concludes with practical recommendations, study limitations, and directions for future research.

LITERATURE REVIEW

Overview of Artificial Intelligence in Business

Artificial intelligence (AI) has gained widespread recognition for its capacity to boost business efficiency, automate processes, and reduce operational costs. Numerous studies have explored AI's role in enhancing productivity and streamlining workflows across various industries (Choi *et al.*, 2023). Research shows that AI-driven automation minimises manual labour, optimises decision-making, and improves predictive analytics, all of which contribute to significant cost reductions (Usman Tariq *et al.*, 2021). Beyond automation, AI applications are integral to digital transformation strategies, enabling businesses to restructure operations and achieve greater overall efficiency (Drydakis, 2022).

Empirical Evidence from Previous Studies

Several studies underscore the impact of AI on reducing operational costs and improving resource utilisation. For instance, research by Heidrich *et al.* (2022) demonstrates that AI adoption leads to a marked reduction in errors and enhanced process efficiency. Similarly, Gans and Nagaraj (2023) found that AI-driven optimisation models can lower costs by improving forecasting accuracy and addressing supply chain inefficiencies. While many studies emphasise AI's transformative potential, few provide quantifiable evidence of its direct financial benefits, leaving a gap in understanding its tangible cost-saving impacts.

A meta-analysis by Paranjape *et al.* (2021) revealed that AI-led automation has resulted in cost savings ranging from 25% to 50% across diverse industries. However, the extent of these savings depends on the implementation strategy and industry-specific challenges. Damioli *et al.* (2024) examined AI's role in workforce efficiency, concluding that while AI-driven enhancements lead to long-term cost reductions, they often require substantial initial investments in infrastructure and training.

Challenges in AI Implementation and Cost Considerations

Despite its advantages, implementing AI presents several challenges, particularly concerning financial investment and workforce adaptation. Studies by Nguyen-Duc *et al.* (2023) and Radanliev *et al.* (2024) highlight difficulties such as high upfront costs, a shortage of skilled personnel, and concerns over data security. Moreover, Drydakis (2022) warns against over-reliance on AI, stressing the importance of maintaining human oversight and conducting continuous evaluations to ensure balanced and effective implementation.

Integration of Research Questions into the Literature Review

To improve clarity and structure, I positioned the research questions at the end of the introduction rather than embed them within the literature review. This adjustment ensures that the literature review remains focused on summarising existing research while situating the study within the broader context of AI-driven cost reduction.

Addressing Grey Literature Concerns

The literature review drew on references from peer-reviewed journals and reputable sources. However, some cited studies originate from platforms like arXiv.org and other preprint repositories. While these sources offer valuable insights, their non-peer-reviewed nature has been acknowledged. Future iterations of this study will prioritise incorporating more peer-reviewed empirical research to strengthen the findings and enhance academic rigour.The results of the paper exhibit that AI can indeed contribute to the strategic goals of Jordanian companies from a cost reduction perspective.

Strategies for Successful AI Implementation

Due to the industry struggling with COVID-19 repercussions, many organisations are considering switching to telework and restructuring their organisation to incorporate some form of working from home. One of the most significant opposing attitudes is the difficulty as people are usually not used to it; to aid this, AI-equipped organisations could use AI-support with worker performance, while knowledge analysis-employment of AI might strengthen employee involvement and corporate income or innovation in organisational processes might impact compliance in organisational results. Alternatively, AI could help support the welfare of employees' analysis and decision-making as learnings and HR management through AI's contribution. With AI HR management or worker protection may add good results to existing operations and human capital allocation in both federal and non-compulsory departments, while in some activities, AI automation again depends on the buyer's choice, and the predicted improvement in the efficiency of performing procedures will reduce product and service expenses. AI could also facilitate safe process and outcome assessments, for instance, within the Indian panel and/or the car department.

Firms should direct their efforts towards maximising the incorporation of AI into internal business processes. AI-assisted marketing and advertising serve as a business tool to automate and streamline promotional activities, as they should strive for more integrated elements among AI integration into business processes, with the possible result being reductions in labour across the division. The AI should

also serve to support further analysis and decision-making, leading to a wider knowledge of transactions. If the adoption of AI is difficult, the averting suggested process can help with that. Companies should also think in terms of AI adoption while they are innovating and adopting business processes. In corporate environments, organisations can derive several benefits from embracing technologies. AI also encourages to increase productivity, competitiveness, expertise, etc. Moreover, using AI tools will make it easier to produce and develop in a collaborative environment and sustain online businesses.

Strategies for successful AI implementation include incorporating cyber-physical systems and digital platforms, using real-time data to drive decision-making, integrating virtual and real systems, managing big data via IoT devices, and using AI for process automation and fault prediction (Vyhmeister & Castane, 2024). Because this technology facilitates the implementation of AI, firms can identify fault predictions using AI to prevent unwanted scenarios and maintain operational excellence through AI (Usman Tariq *et al.*, 2021). Besides, firms should focus on integrating virtual and real systems and designing AI algorithms suitable for cyber-physical systems and digital platforms, as this creates greater flexibility in production.

Based on the identified objectives and the gaps, I sought to answer the following questions:

RQ1: How do AI applications influence operational costs in Jordanian companies?

RQ2: What are the main challenges and opportunities that Jordanian companies found in integrating AI into their operations?

RQ3: Based on the findings, what strategic recommendations could be provided to Jordanian companies looking to implement AI to reduce operational costs?

Cost Reduction Techniques with AI

Prescriptive analytics or other combinations of machine learning and operations research models can help optimise workforce schedules or machinery deployment on a real-time basis. These same techniques also commonly serve to optimise product mix and stock levels and help support the demand planning process, which if not optimised, has a direct impact on direct material waste. In pricing, AI can reduce direct material costs by improving the ability to set appropriate pricing and price promotions for products, leading to reduced discount spending, and funding costs, and lower overall selling, general, and administrative costs.

Artificial intelligence automates routine activities, reduces errors, and does not tire. The following are some common AI tools and techniques that can help reduce labour costs and optimise other operational costs: robotic process automation (RPA) automates rule-based, repetitive tasks previously performed by humans, such as bulk data entry, inventory control, and automated testing. It can read and interpret various files from one format to another, creating reports and analysing data. Natural language processing (NLP) and other AI text analysis tools can process unstructured data (*e.g.*, emails, financial reports, or web click data) into a structured format to help forecast financial metrics, perform predictive customer analysis or stock trend analysis, conduct market surveillance, and conduct fraud detection activities (Ameen *et al.*, 2021).

In today's challenging world, reducing operational costs has become second nature for the majority of companies in all industries (Maple *et al.*, 2023). Reducing operational costs generally means reducing the cost of labour, utilities (such as electricity and water), materials, and supplies. However, the main focus has always been the cost of labour because the more people are employed, the more daily operational costs must be regulated to maintain pre-established profit margins. Artificial intelligence has the potential to significantly cut operational costs and is also, in many ways, even more efficient than traditional methods (Dionisio *et al.*, 2023).

AI Tools and Technologies for Cost Reduction

Artificial intelligence technologies used for cost optimisation include connected devices, robotics, virtual agents, and computer vision systems. It is physically connected to other devices and systems while connected devices have built-in AI capabilities such as perceptiveness and the ability to make autonomous decisions. Robotics recognise or use AI to add new abilities. Virtual agents are implemented to respond via text and internet meetings to customers or stakeholders. Computer

vision refers to the computers' ability to recognise and understand physical objects and then act upon the built-in image of those real-world objects. The above two lists are not comprehensive but cover some of the AI tools and technologies used to reduce operational costs.

Artificial intelligence tools used for cost optimisation include RPA, predictive analytics, data visualisation, natural language processing, and machine learning. Noteworthy, RPA refers to the automation of rule-based tasks via software robots. It can save human effort while requiring minimal modification to existing systems. Predictive analytics enables organisations to predict future outcomes considering patterns in their past data. Data visualisation is about representing information in graphical form to help in understanding, reasoning, and decision-making. It allows users to see communications that transcend their data or analytical skills. Natural language processing is closely associated with artificial intelligence, and a set of AI techniques used to analyse and understand the human language. Machine learning focuses on predicting outcomes from data. People analyse data to build models, which can be thought of as representations of patterns in the data. Using machine learning models, the company can predict future outcomes provided what happens.

Artificial intelligence refers to the simulation of human intelligence processes to perform tasks. These tasks include but are not limited to learning, understanding, reasoning, problem-solving, perceiving images, recognising speech, and translating languages (Usman Tariq *et al.*, 2021). The cost of AI, like most technologies, has decreased significantly while generic processing tasks have increased. The decrease in the cost of data storage and improved algorithms have presented and improved AI technologies (Panchal *et al.*, 2024). Several AI tools and technologies typically serve cost reduction which one can further explain as follows (Machado *et al.*, 2020).

Training and Skills Development for AI Implementation

Limited exposure to subjects such as core AI concepts, ML, deep learning algorithms, applications of AI in various fields of economy and business, and its social, legal, and ethical impacts is the major concern of AI Skill Education. Cultural and philosophical differences could further impede the application of a universal educational framework. Thus, a more typical approach might involve the definition of suitable AI learning goals for society as a whole, the definition of national or regional educational objectives, and the customisation of such educational objectives to suit the needs and objectives of individual schools. It might also be wise to provide as much localisation as feasible, considering the various cultural and philosophical influences. Artificial intelligence is both a fundamental skill and a transformative technology. Just like the internet, AI can fundamentally change commerce, legislation, trade, and ethics. AI skills for every interaction are important. Governance initiatives will be required to ensure that all people have these abilities. This transformation can occur in close partnership and as a part of ongoing school assignment strategies or in a more independent manner.

The transformation of industries can have immediate and lasting effects on workers (Gupta, 2020). AI has the potential to alter the key drivers of economic growth and highlights the importance of well-structured re-growth and reskilling programs (Choi *et al.*, 2023). Moreover, successful AI adoption increases the productivity of the industries and boosts the returns on investment in AI systems (Nguyen-Duc *et al.*, 2023). Reskilling of current employees and training of new AI teachers are the pillars of AI education and skill development. Integrating AI into the curriculum and placing AI teachers at the strategy level are a few measures that will be beneficial in schools. Incorporating AI into academic curriculum is a multiheaded matter, requiring an assessment of administrative, logistical, and instructional effects. The approach or incorporation has its own set of fickle components, including the time needed for educator training, academic governance control of what is added to the curriculum, and administrative decisions regarding budget and student capacity.

Ethical Considerations in AI Adoption

At the same time, it is plain that organisations often face special business pressures and regulatory burdens in regulated environments. Where human jobs are lost or where the human – and sometimes corruptible – interpretation of ethical guidelines might prove ineffective when data becomes vast, rapid AI deployments may often provide almost immediate and auditable reviewability, creating a trail for

regu-lators and ethics boards alike. AI has often heightened ethical concerns, but for many use cases, it provides new options for enumerating, auditing, and managing downstream business risks. As several case studies below illustrate, these trends and AI's possible impact on them are highly idiosyncratic to individual functional areas, different levels of sectoral development, and the organisation using AI, predicated on such diverse specifics of domain and tooling as the features of machine learning languages different sectors apply, not just the use of deep learning per se. AI and ethics present themselves as the issues that organisations and societies most need to address. The conversations we have today will not only shape the rules of the road in data-driven sectors but will also chart the paths our societies decide to take in deploying advanced, sometimes autonomous systems across numerous organisational functions. Fortunes, regulatory frameworks, and quality of life outcomes will be set for much of this century by how we grapple with these concerns now. This is why it is key for the nations of the world, the representatives of the people, to consider AI regulation. Many nations are beginning to establish or elucidate their own AI regulatory frameworks, or else to negotiate multistakeholder agreements at international fora. Besides these lawful downsides, ethical AI increasingly looms.

Ethical considerations in AI adoption have gained a lot of attention in industry, academia, and policy nowadays (Pachegowda, 2023). Issues such as bias, security, and privacy violations have often been raised as reasons for caution or resistance to AI adoption (Radanliev *et al.*, 2024). Many factors combine to create regulatory and ethical pressures: the rising potential for AI to infer and act on discriminatory behaviours; growing attention to fairness in machine-learning models; and increasing expectations that AI ethics considerations will be incorporated into regulatory requirements. In some scenarios, concerns may be tempered by the relative ease of addressing bias in a given analytic use case; in others, the result will be years of scrutiny and multi-million-dollar fines for algorithmic interventions that prove unreliable or biased in simply reflecting existing human attitudes or actions. In the worst cases, the stakes are higher, with broken or biased AI decisions causing real harm, such as in healthcare, criminal justice, and finance (Gwagwa *et al.*, 2021).

RESEARCH METHODOLOGY

I adopted a qualitative research approach, focusing on a literature review and thematic analysis to investigate the role of AI in reducing operational costs for businesses in Jordan. Rather than collecting empirical data, the research synthesises insights from existing studies and industry reports to provide a comprehensive understanding of how AI impacts cost reduction.

Literature Review

I relied heavily on a systematic literature review to build a theoretical framework for understanding AI's influence on operational costs. I analysed peer-reviewed journal articles, industry reports, and relevant case studies from various sectors to identify key trends, benefits, and challenges associated with AI implementation. The literature review served as the primary source of data, enabling an assessment of AI's effectiveness in enhancing business efficiency and achieving cost reductions.

Thematic Analysis

A thematic analysis was performed to identify patterns and recurring themes within existing research. This method facilitated a structured exploration of AI adoption, its advantages, and the obstacles businesses encounter when integrating AI technologies. Key themes examined include AI-driven automation, resource optimisation, cost-efficiency strategies, and the role of digital transformation in modernising business operations.

Case-based Discussion (Non-empirical case studies)

Although the study references examples of AI applications across different industries, it does not involve original case studies based on primary data collection. Instead, it synthesises secondary case studies from existing literature to highlight instances of AI-driven cost reductions in various sectors. These discussions provide real-world context without engaging in direct empirical investigation.

Strategic Insights and Recommendations

Based on the findings from the literature review and thematic analysis, I developed strategic insights to offer practical recommendations for Jordanian businesses considering AI adoption. These recommendations are derived from best practices identified in prior studies and industry reports, helping organisations understand AI's potential while addressing the challenges associated with its implementation.

RESULTS AND DISCUSSION

The results and discussion section highlights the significant potential of AI in driving cost reduction across industries through three primary strategies: automation and process optimisation, predictive analytics for enhanced decision-making, and improved resource utilisation. Moreover, other results are discussed as follows:

1. Cost reduction strategies enabled by AI (based on the literature review)

– Automation and process optimisation: AI boosts efficiency by minimising manual tasks and enhancing precision.
– Predictive analytics and decision-making: AI-powered forecasting supports better cost management within supply chains.
– Resource utilisation optimisation: AI reduces waste and improves the allocation of resources across various industries.

2. Challenges in implementing AI

– High upfront costs and uncertainties about return on investment.
– Workforce readiness issues and gaps in necessary skills.
– Regulatory and ethical hurdles associated with AI adoption.

3. Thematic insights from the existing literature

This section includes a Table summarising findings from reviewed studies:

Table 1. Findings within previous studies

Theme	Findings from the literature
AI-driven automation	AI reduces labour costs, enhances efficiency in repetitive tasks, and minimises human errors (Choi *et al.*, 2023).
Predictive analytics and forecasting	AI-driven data models enhance supply chain efficiency by reducing waste and eliminating excess inventory (Paranjape *et al.*, 2021).
Cost reduction within customer services	AI-powered chatbots and virtual assistants decrease the need for human customer service representatives, thereby lowering operational costs (Drydakis, 2022).
AI in predictive maintenance	AI-based maintenance systems reduce downtime in manufacturing, improving machine efficiency and minimising operational disruptions (Damioli *et al.*, 2024).
AI in supply chain and logistics	AI optimises transportation routes, cuts fuel expenses, and enhances inventory management (Nguyen-Duc *et al.*, 2023).
AI-driven decision support systems	Businesses leveraging AI for strategic decision-making achieve reduced operational inefficiencies and improved resource allocation (Gans & Nagaraj, 2023).
Challenges in AI adoption	High initial investment and a shortage of skilled workforce are significant barriers to realising AI's cost reduction benefits (Radanliev *et al.*, 2024).

Source: own study.

The findings from the existing literature underscore AI's transformative potential in reducing costs across various industries. Automation and predictive analytics have proven particularly effective in minimising errors, optimising supply chains, and cutting waste, resulting in significant operational savings. Nevertheless, the adoption of AI remains inconsistent, largely due to high upfront costs and the demand for a skilled workforce (Radanliev *et al.*, 2024). Businesses must carefully assess their AI strategies to ensure that anticipated cost reductions justify the necessary investments. Companies that

successfully incorporate AI into areas such as customer service, supply chain management, and predictive mainte-nance are more likely to achieve sustained improvements in cost efficiency. While the literature highlights AI's ability to enhance operational efficiency, further research is essential to measure its long-term financial impact and evaluate the adaptability of AI-driven solutions in diverse economic contexts.

CONCLUSIONS

I examined the role of AI in reducing operational costs for Jordanian businesses using a systematic literature review and thematic analysis. The findings reveal that AI-driven solutions, including automation, predictive analytics, customer service optimisation, and supply chain efficiency, play a significant role in cutting costs across various industries. Nevertheless, the success of AI adoption is shaped by factors such as high upfront investment, workforce preparedness, and integration challenges. While AI offers considerable potential to improve operational efficiency, businesses must adopt strategic approaches to implementation to fully realise its benefits.

This study relied on secondary data sources and did not incorporate empirical case studies or primary data collection. Consequently, the findings are based on existing literature rather than direct industry-specific research. Furthermore, while the study focuses on Jordanian businesses, its findings may not be fully applicable to other regional or global markets due to differences in economic conditions and levels of technological adoption. Another limitation is the absence of quantitative cost assessments, as the majority of the reviewed studies emphasise qualitative insights rather than providing precise measurements of financial impacts.

Future research should investigate empirical case studies to validate the cost-reduction benefits of AI in Jordanian businesses. Conducting industry-specific surveys and financial impact assessments would yield quantifiable data on AI's return on investment (ROI). Moreover, further studies could explore the long-term effects of AI adoption, particularly focusing on how businesses address post-implementation challenges such as AI maintenance costs, workforce adaptation, and regulatory compliance. Extending the research to other Middle Eastern markets would also provide valuable comparative insights into AI adoption trends and cost-saving strategies across diverse economic contexts.

Recommendations

According to Deloitte, companies are more frequently implementing or expanding AI solutions and targeting AI efforts on the functions most commonly identified as priorities, such as IT, marketing, customer service, and research and development. As companies develop their AI strategies, investments in AI training and communication are also more often cited as critical enablers of AI, suggesting a growing awareness of the need to invest not only in technology but also in the skills and operational readiness required to realise AI's potential. Anytime AI is going to be used, no matter if the application is simple or complex, one should think it through strategically (Kumar *et al.*, 2021). The literature states that an application can go from being simple to complex and any sort of positive narrative about its effects on both professionals and businesses must be based on careful numbers (Gans & Nagaraj, 2023). Furthermore, companies must comply with regulations tied up with AI use as each country's laws are subjective.

Adopting AI applications is crucial for enhancing a company's competitiveness, as it can enable processes smartly, and efficiently, and enhance the decision-making processes inside the company (Heidrich *et al.*, 2022). This study recommends having a strategy for the development of AI technology within the companies. Companies must set a clear future about what to develop, whether to work on it or just work with technology and software, or to trade in such technology. It is also important to develop a vision for work in the field of AI and set goals, performance indicators, and budgets. Moreover, it is important to develop a method to take advantage of AI's benefits. The study recommends that companies create a plan for the development of AI solutions for the entire company as well as pilot projects. Through these projects, companies learn more about AI usage and maintain

the ability to implement whole AI solutions in companies, some of the AI solutions the companies can use, including also how the companies can make revenue from this investment.

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Acknowledgements and Financial Disclosure

Thankful and sincere gratitude to all interviewees from Jordanian companies whose insights and corporations were invaluable to this study. There is no fund received for this study.

Use of Artificial Intelligence

The author confirms that the text is free from AI.

Conflict of Interest

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International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.02

The counterparty credit risk appetite in the Polish over-the-counter derivatives market

Piotr Wybieralski

ABSTRACT

Objective: The article aims to study the selected approach used to manage the counterparty credit risk, namely the application of the pre-settlement risk limits in the Polish over-the-counter derivatives market between financial institutions and non-financial counterparties. Since market practice differs in terms of hedging the same risk exposures of non-financial counterparties, the main goal is to identify and analyse key factors determining the risk appetite of financial institutions reflected in the pre-settlement limit amount.

Research Design & Methods: I based the theoretical considerations on the literature analysis. I utilized secondary data analysis and desk research, in particular concerning legal regulations both on the European and Polish levels. It considers credit policies and the counterparty credit risk rules of selected banks listed on the Warsaw Stock Exchange that offer derivative instruments for non-financial counterparties in order to hedge against specific market risks. I investigated all required information and data obtained and proceeded by banks for treasury limits. For this purpose, I analysed credit application forms and treasury limit applications. Next, I investigated the principles for managing counterparty credit risk as well as appropriate credit policy. A case study presents key differences in banking services provided for a non-financial counterparty willing to hedge market risks.

Findings: I applied a holistic approach to the counterparty credit risk policy and identified key factors affecting the counterparty credit risk appetite within financial institutions, reflected in the pre-settlement limit granted to non-financial counterparties in the Polish over-the-counter derivatives market. These determinants concern areas such as specific hedging instruments, given counterparty and financial institutions, as well as the regulatory environment.

Implications & Recommendations: The pre-settlement risk limits serve not only to cover credit exposure but also to support and enhance the entire market risk management process and day-to-day operations in financial institutions. One may also regard the implemented treasury limit setup, risk factors, margining policy, etc., in the context of competitive advantage that financial institutions may gain and thus attract more derivative business. Hence, it is crucial to recognize determinants influencing the treasury limit amount.

Contribution & Value Added: Although the main analysis of counterparty credit risk concentrates on interbank operations, mainly due to their high systemic importance, the management of the pre-settlement risk in the over-the-counter derivatives market between the financial institution and non-financial counterparty should be considered in more detail due to its growing importance. This article intends to systematize knowledge on this topic. The case study utilising international and domestic experiences shows different approaches to mitigate financial risks. The question of which approach to risk management is more effective remains open.

Article type: research article

Keywords: counterparty credit risk; pre-settlement risk; CCR limits; OTC derivatives market

JEL codes: F31; F37; G15; G32

Received: 20 June 2024 Revised: 6 January 2025 Accepted: 26 March 2025

Suggested citation:

Wybieralski, P. (2025). The counterparty credit risk appetite in the Polish over-the-counter derivatives market. *International Entrepreneurship Review,* 11(3), 17-27. https://doi.org/10.15678/IER.2025.1103.02

INTRODUCTION

Despite many undertaken regulatory actions, the counterparty credit risk[1] (CCR) management still remains relevant and up to date. Both the Federal Reserve (FED, 2024) and The European Central Bank (ECB, 2022) highlight the importance of this topic.[2] Polish financial institutions are also not immune to CCR-related challenges, which appear especially in times of major market turbulence caused by unexpected events, such as the 2008/09 Global Financial Crises, the outbreak of 2020 Coronavirus Pandemic, or the Russian invasion of Ukraine in 2022.

I aimed to study the application of treasury limits in the Polish over-the-counter (OTC) derivatives market to cover pre-settlement risk.[3] I paid special attention to the relationship between financial institutions and non-financial counterparties. The existing research concentrates on various risk limits, especially in the interbank market (among financial institutions). There is no comprehensive view on this topic in the analysed area, hence the study intended to fill this gap.

The article tries to examine why the amount of the pre-settlement limit set by banks for a given counterparty may differ, despite reporting the same needs in terms of financial risk hedging. Hence, the research question was: What are the key factors determining the financial institutions' CCR appetite that is reflected in the pre-settlement limit granted?

The applied research method comprised the analysis of various legal regulations both on the European and Polish levels. It also considered credit policies and the CCR rules of selected banks listed on the Warsaw Stock Exchange. A presented case study shows key differences in banking services provided for a non-financial counterparty willing to hedge market risks.

This article contributes to the literature on finance, with a particular focus on market risk management. The findings offer valuable insights for business practice, benefiting both financial institutions and non-financial counterparties. Financial institutions formally required to implement counterparty risk monitoring systems through CCR limits can leverage these results to enhance their practices. Meanwhile, non-financial counterparties may gain additional understanding and develop their knowledge and competencies in risk management. The study also holds significance for academic researchers, providing a basis for further exploration of these areas and inspiring the development of innovative solutions.

The article is organized as follows. The first section will present selected references on CCR management approaches. Then, it will depict the research method employed. Next, I will present the key factors determining the amount of pre-settlement risk limits. Subsequently, the discussion section will cover observed differences and practical implications for Polish financial institutions. The last part will contain conclusions and suggestions for further research.

LITERATURE REVIEW

There are many approaches to mitigate CCR, such as trade novation with central counterparty (CCP), credit valuation adjustment (CVA), or the application of risk limits.

In centrally cleared transactions, the CCP assumes the role of the buyer to the original seller and the seller to the original buyer (Duffie & Zhu, 2011; Norman, 2011; Rehlon & Nixon, 2013; Berndsen, 2021). The CCR is mitigated through mechanisms such as multilateral netting and collateral posting. Contract settlements are further safeguarded by default management procedures and dedicated financial resources. While centralized clearing offers many benefits, some researchers highlight potential risks. For instance, Koeppl (2013) discusses how centralized clearing can create incentives for moral

[1] Counterparty credit risk means the risk that the counterparty to a transaction could default before the final settlement of the transaction's cash flows (Art. 272, Regulation (EU) No 575/2013)

[2] The European Central Bank (ECB) identified exposure to counterparty credit risk as a supervisory priority for 2022 and initiated a range of supervisory actions.

[3] The CCR consists of pre-settlement and settlement risk (Art. 286.2b, Regulation (EU) No 575/2013). The key role in this distinction plays the timing when a specific type of risk occurs. The pre-settlement risk relates to the period from the deal date to settlement date, while the settlement risk relates only to the cash flows at the contract maturity. The latter risk is not a particular challenge in the analysed area due to delivery vs. payment rule in place (although settlement limits may also apply).

hazard, while others argue that trade novation may increase systemic risk by mutualizing the idiosyncratic risk (Pirrong, 2012; Biais *et al*., 2012; Menkveld, 2015; Gregory, 2010).

The CVA approach adjusts the contractual price by incorporating an appropriate risk spread when entering a transaction (Brigo *et al*., 2013), thereby creating an internal default fund. The CVA framework should account for counterparty-specific master netting agreements and margin terms. However, estimating the risk premium for each trading counterparty under this framework can be particularly challenging in practice (Gregory, 2010; Cesari *et al*., 2010; Barucca *et al*., 2020). The CVA-based approach is also not suitable for assets traded on an exchange (Gould *et al*., 2013).

The CCR limits are widely used in practice not only to mitigate credit exposure but also to enhance market risk management processes and day-to-day operations. They allow the maximum exposure that an institution faces from derivatives trading with any other counterparty to be set (Gould *et al*., 2017a and 2017b; Gregory, 2010). They usually cap a maximum exposure above which the collateral has to be posted (margin call rule applies). Pre-settlement risk (PRE) accounts for basically two components, namely market risk estimation and portfolio valuation. Hence, potential future exposure (PFE) and current exposure (CE) jointly determine the PRE. The PFE is very often computed using the VaR approach (Best, 1999). However, the PFE is positive and covers longer periods. The CE is calculated either as a net present value (NPV) of all non-matured contracts or the value of reverse transactions. Some recent works[4] on the PRE concentrate *i.a.* on collateral value, especially different initial margin models (Gregory, 2016; Anfuso *et al*., 2017; Caspers *et al*., 2017; McWalter *et al.,* 2018; Caspers *et al.,* 2018). As a result of bilateral initial margining their impact on derivatives pricing is analysed through so-called valuation adjustments (Vierkoetter, 2019).

The existing literature concentrates mainly on various risk limits, especially in the interbank market. There is no in-depth research on this topic from the perspective of the relationship between a financial institution and a non-financial counterparty.

RESEARCH METHODOLOGY

I aimed to identify the key factors determining the pre-settlement limit amount granted to non-financial counterparties by financial institutions in the Polish OTC derivatives market. I utilized secondary data analysis and desk research, in particular concerning legal regulations both on European and Polish levels.

In accordance with Recommendation A of the Polish Financial Supervision Authority (FSA 2010 and 2022), the pre-settlement limit[5] is required for concluding different derivative transactions. It is employed mainly to manage the counterparty credit risk exposure stemming from derivatives trading.[6] Data source covers selected commercial banks listed on the Warsaw Stock Exchange (WSE) that offer non-financial counterparties (entrepreneurs) derivative instruments to hedge specific market risk exposure (foreign exchange, interest rate and commodity risk). The article investigates all required information and data obtained and proceeded by banks in the credit application process for treasury limits. For this purpose, the credit application forms and treasury limit applications are analysed in the first place. Next, the appropriate credit procedure is examined (usually on credit policy for working capital financing) and adopted principles for managing counterparty credit risk (CCR policy).

The case study considered the CCR limit request for one entity from a capital group operating in Central and Eastern Europe. The company deals with agriculture cultivation combined with animal husbandry. As other activities, it states cultivation of cereals, legumes, and oilseeds for seeds as well as services activities supporting plant production, post-harvest services, wholesales of grain, seeds,

[4] Since the BCBS-IOSCO guidance on margining for non-centrally cleared derivatives in March 2015.

[5] Used in practice under different terms, such as 'credit lines,' 'pre-settlement treasury limits,' 'counterparty limits,' 'CCR limits,' 'transaction limits,' 'counterparty risk exposure limits,' etc. In this article, I define the pre-settlement limit in accordance with Recommendation A of Polish FSA (2010:18 p.1.6.4.a)

[6] The available treasury limit amount together with current risk requirements directly determine the notional value of the derivative transaction. After transaction conclusion the limit utilization is verified on a daily basis (to monitor and manage counterparty credit risk exposure). Usually, once the treasury limit is fully utilized, the margin call clause is triggered/issued meaning the additional collateral has to be posted or the transaction prematurely closed out and cleared. This action aim to limit the risk exposure from derivatives to the pre-settlement limit amount.

and animal feed. It conducts activities related to plant cultivation in an area of approx. 10 thousand ha. Market risks stem from the commodity exposure related to production (including wheat and rapeseed, additional expenses such as fuels), and currency exposure results from direct EU payment to the area (payments per hectare in PLN, but indexed to EUR). The application was submitted to two banks in the OTC market to check transactional availability as well as terms and conditions. Both banks are WSE-listed. However, bank A operates only locally (domestically), while bank B is a member of the leading European banking group (in terms of assets, it ranks among the largest European banks). Although reporting the same needs in terms of financial risk hedging, the entity is given two different proposals in terms of banking services (*i.a.*, various pre-settlement limits).

RESULTS AND DISCUSSION

A non-financial counterparty willing to enter into derivative transactions in the Polish OTC market should meet a number of conditions. The most important is to sign an appropriate documentation package, most often a master agreement with related annexes, among others, regulations, general terms and conditions, fill in the appropriateness test[7] (Markets in Financial Instruments Directive – MiFID), organize the LEI code (European Market Infrastructure Regulation – EMIR) and apply for a treasury limit (Recommendation A of PFSA 2010 and 2022). Request for a treasury limit requires a credit application process. The whole credit assessment is very similar to other working capital facilities and entails both the client's creditworthiness assessment and transaction evaluation (Polish Banking Law). The treasury limit is very often subtracted from the client's total approved credit, and the amount is based on the counterparty's profile and needs. Firstly, all information required to prepare the treasury limit is collected. The counterparty fills in the standard credit application (as for any other financing), usually together with the treasury limit application form. Then, a treasury unit prepares a recommendation in accordance with the CCR policy set in a given financial institution. The limit amount is estimated on the specific market risk exposures and applicable risk requirements for planned instruments. Next, the credit analyst evaluates the counterparty creditworthiness (based on current financial statements and forecasts) for the requested limit amount in accordance with the proper methodology. As for all credit lines there are different types of collaterals being also analysed. In general, there are cash or non-cash collaterals (or both). The credit decision is made at the proper credit committee level (it may be positive, negative or conditional – requires additional changes), and then a documentation package is prepared. After signing the agreement and meeting the initial conditions, the treasury limit is implemented into the bank's system, and the counterparty is able to conclude different financial instruments. During the lifetime of the treasury limit, its utilization is monitored on a regular basis. If it is fully utilized no more instruments can be opened until it is released. If the positive from the bank's perspective value of non-matured contracts matches (utilizes) the whole limit amount (together with additional collaterals paid in), the margin call rule usually applies. The treasury limit for daily business usually expires after one year or is renewed. An active derivative instrument should have a valid treasury limit. This means that if the limit expires, the transaction ought to be closed, or additional collateral should be posted. In the case of credit-related instruments the limit tenor is usually longer and adjusted to the planned hedging instrument.

The factors analysis determining the treasury limit amount followed the credit application process that indicates two main stages, namely when the limit is computed and then verified and granted. The calculation is prepared by the treasury department based on the current CCR rules. Before entering into any derivative contract, the counterparty should be verified in accordance with DIRECTIVE 2014/65 (MiFID) and the assigned target group (Table 1).

Then, risk exposures and the counterparty's hedging policy should be analysed in connection with the financial institution's CCR management policy, including proposals regarding available collateral.

[7] When assessing appropriateness, a financial institution must determine whether the counterparty has the necessary experience and knowledge to understand the risks involved in relation to the product or service offered.

All these factors affect the amount of treasury limit, the scope of available instruments offered, the tenors of both hedging instruments and requested limit and finally, the form of limit collateral.

Table 1. The determinants of pre-settlement risk limits amount to be recognized and analyzed by the treasury department unit

No	Criteria/Factors	Impact/Description
1	Counterparty category under MiFID	*I.e.*, retail customer, professional customer or eligible counterparty. Additionally, retail customers should be assessed in terms of the appropriateness of financial instruments and services (survey on customer knowledge and experience).
2	Target group	Assigning counterparty to a target group to which the institution offers the financial instruments as part of the investment service.
3	Description of risk exposures and counterparty's hedging policy	A detailed description of hedging policy (current/operating or strategic/long-term hedging), in particular: - risk exposures to be hedged with derivatives, such as foreign currency exposure (in- and out-flows, hedge ratio, contracts tenors, time of risk exposure, the origin of risks, *etc*.); interest rate exposure (whether it is an investment loan, bond issue, leasing etc.) repayment schedule, amortization amount etc., commodity exposure (amount/quantity, underlying index, terms, *etc*.), - applicable instruments in hedging activities, Determination of the transaction purpose to be concluded within treasury limit (investment goal, speculative [non-hedging] or hedging activity).
4	Financial institution's CCR management policy	In particular: - treasury limit setups, - limit utilization schemes, - risk requirements for computation of potential future exposure, - valuation methods of current exposure, - margining policy, - other.
5	Collateral form for treasury limit	Whether it is unsecured or secured (cash or non-cash form), and whether or not an initial margin is required. When exactly is the margin call triggered, and how much variation margin should be posted? There may also be limits without the margin call rule.

Source: own study.

Next, the credit risk department is responsible for the evaluation of both the creditworthiness and applicable collateral in accordance with credit methodology for a given business counterparty line (Table 2). Within financial institutions' credit policy, the main factors are (i) the credit rating system, (ii) the evaluation of credit exposure and creditworthiness and (iii) collateral.

Table 2. The determinants of pre-settlement risk limits within financial institution credit policy

No	Criteria /Factors	Impact/ Description
1	Credit rating system	The rating system verifies counterparty financial standing and impacts in the case of working capital financing facilities *i.a.*, the scope of available instruments, the credit amount, collateral form and ultimately, the costs (fees and margins). In the case of treasury limits, credit rating similarly determines whether the financial institution is willing to engage in a specific counterparty and to what extent. There is usually no up-front fee and no margin on treasury limits. The bank benefits from transactional spreads. Credit rating directly affects the amount of treasury limit and collateral form.
2	Evaluation of credit exposure and creditworthiness	The bank is obliged to verify creditworthiness for requested credit exposure. Some financial institutions determine the maximum amount of treasury limit in relation to the company's turnover (*e.g.*, no more than 10-20% of annual turnover), others in relation to EBITDA (*e.g.*, no more than 50% of the last year EBITDA), others in relation to counterparty equity (*e.g.*, no more than 50% equity value).
3	Collateral examination	An analysis of legal collaterals applicable to credit limits is conducted in accordance with the bank's policy in this regard.

Source: own study.

The final decision on the treasury limit amount considered various factors related to the planned instrument, given the counterparty and financial institution specifics on CCR management, credit risk policy, and the regulatory environment (Figure 1).

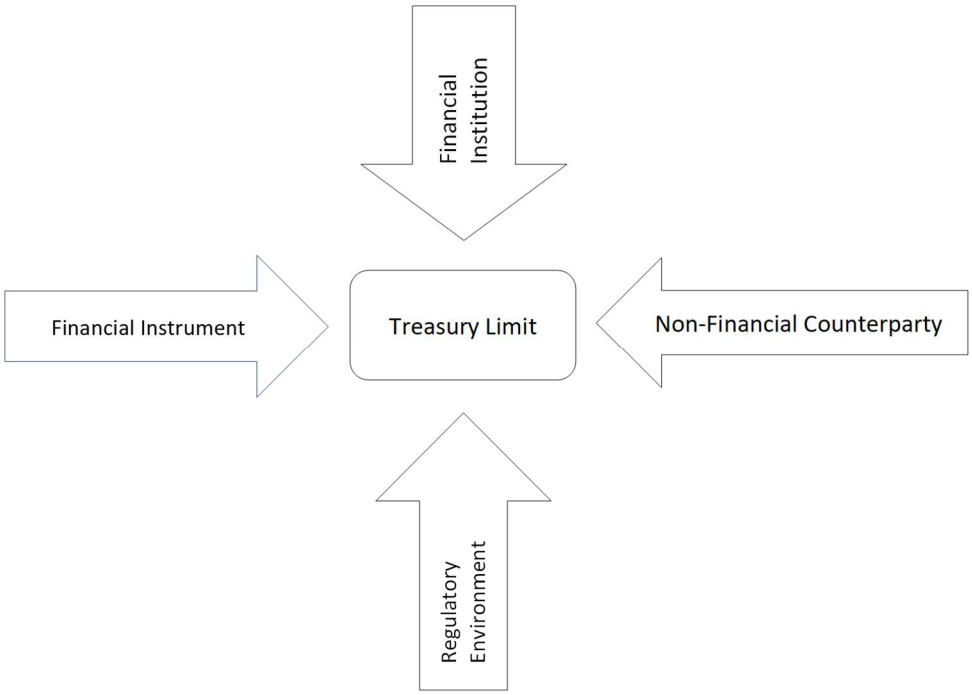

Figure 1. The key areas of treasury limits determinants
Source: own elaboration.

The case study considered in this article concerned the application process for a treasury limit in the relationship between a financial institution and a non-financial counterparty. It turned out that once the application was submitted, the received proposals were heterogeneous. The differences concern the CCR policy, including limit type, limit amount, margining rules, and others. Bank A offered a mutual/common CCR limit (there are sub-limits for currency and commodity exposure), while Bank B proposed a separate limit for each market risk (*i.e.*, single for both currency and commodity exposure). It is particularly interesting that the total amount of both limits in Bank B differs from the amount of the limit in Bank A, despite applying the 95% confidence level in market risk estimation. The limit utilization scheme was similar in both banks, assuming variable risk requirements. The margin call was issued when the limit was fully utilized. However, the minimum transfer amount differed in both banks.

Although financial institutions collect similar data from their counterparties and proceed to determine the treasury limit and set cooperation conditions, the final decision may be different across banks (in detail) in terms of (i) the scope of available hedging instruments, (ii) transaction tenor as well as limit tenor, (iii) limit amount, and (iv) the form of the collateral required. This is because of the different approaches a given institution takes in terms of the implemented counterparty risk management principles and the credit risk policy (credit methodology).

Regarding counterparty categories under MiFID and the distinction between a professional customer, an eligible counterparty, or a retail counterparty, the financial criteria are generally not particularly challenging (they are indicated in Directive 2014). However, some differences arise when examining the retail customer's knowledge and experience. Due to the lack of standardization of MiFID tests among financial institutions and different checking algorithms applied, it may happen that a given counterparty may use the entire range of derivatives offered in one institution while the scope of instruments may be limited in another one.

This is particularly important since the instrument type directly affects the treasury limit amount. As for derivatives, most of them generate counterparty risk and require treasury limits.

However, there are a few exceptions that are free from this risk, such as option purchase with premium payment on the deal date (Wybieralski, 2023). However, when the premium is shifted to the option maturity then a treasury limit is required. Flexible solutions (*e.g.*, selected option strategies, enabling participation in positive market changes) utilize limits to a lesser extent compared to fixed ones (*e.g.*, foreign exchange forward contracts).[8]

Especially important factors are those directly related to the exposure being hedged, *i.e*. the risk sources, the transaction amount, and the contract tenor (in the context of the probability of risk materialization). The type of hedging policy (both on the bank side as well as counterparties) directly affects the amount of the limit.[9] Risk sources and exposure origins are important. Are these specific invoices (already issued/received) or future, just planned cash flows? In the case of the former, the perfect hedging (100% of the exposure) is not usually problematic. In the case of the latter, a maximum hedging level/ratio may be set, *e.g.*, no more than 80%.[10] This is about operational (current) or strategic (long-lasting) hedging policy. Derivative tenors up to 12-24 months are generally possible (tradable) in analysed banks. However, transaction tenors above six months may require more detailed projections and justification in some institutions. There are also a few banks that enable strategic hedging in longer time frames, *e.g*., up to five years (introducing some constraints, *e.g.*, no more than 20% of the annual FX turnover to be concluded in such instruments, Wybieralski 2020). However, long transaction tenors are more or less challenging, especially those exceeding the treasury limit tenor. Longer trades utilize treasury limits to a greater extent due to the higher risk involved. Dilemmas on limit amount emerge after its expiration while renewing process. Whether the original value should be requested or the amount that is based on the current risk requirements (*e.g.*, lower due to time decay)? Another issue deals with the bank's collateral policy on non-matured transactions after the limit expires (and is not renewed). Whether hedging instrument should be premature closed-out or just additional collateral should be posted?

Risk requirements are extremely important in terms of potential future exposure (PFE) and limit amount estimation. Banks often apply different VaR approaches to calculate risk factors (in terms of the method used, reference markets, time series, confidence levels, etc.) and update them differently. This means that risk requirements may vary in individual institutions. Thus, specific trades usually utilize treasury limits differently across financial institutions.

The limit tenor for daily business is usually up to 12 months. In the case of credit-related transactions, it is usually longer and matches the maturity of the interest-hedging instrument. A complication may arise when a company concludes both daily hedging (*e.g.*, foreign exchange) and credit-related hedges. Are there two single limits in place (separate limits for each specific market risk) or just one with sublimits (and then what is the limit tenor and expiration date)? The practice differs in this regard within analysed banks.

The nature of the planned transactions usually affects the collateral form of treasury limit. The real cash flows (financial) hedging is concluded very often within unsecured limits (no initial margin required). Non-hedging activities (speculative transactions), if allowed, they are usually concluded within secured limits (initial margin has to be posted).

The adopted limit utilization scheme has a significant meaning. The CCR exposure can be calculated differently. It usually consists of PFE and CE. The question arises of whether the treasury setup employs and maintains the fixed (original) or variable risk requirements and what the holding period is. It is connected with the margin call policy, which specifies when exactly and how much variation margin should be posted. Within selected banks (WSE listed), the dominant pattern for daily business and one-off transactions under pre-settlement risk limits applies variable risk requirements

Regarding credit policy, credit analysts usually follow credit methodology for working capital financing to evaluate treasury limit amounts. As mentioned, credit rating plays a crucial role in influencing both the amount and the collateral form. Financial institutions may distinguish between the limit amount and threshold amount in their internal systems. In that case, the former determines the no-

[8] Refers to the same notional amount in hedging instrument within a granted limit, see Wybieralski 2015a and 2015b.

[9] Relates to daily business transactions (such as foreign exchange and commodity) as well as one-offs (credit-related instruments).

[10] Cash flows probability should be weighed in terms of transaction tenor.

tional position across different time tenors, and the latter determines unsecured credit exposure (above which the collateral has to be posted; the margin call rule applies). The limit amount often equals the threshold amount. However, the limit amount may be higher than the threshold amount, which means that the bank is willing to conclude the planned transactions within specific tenors but accepts lower credit exposure (margin call may appear earlier/sooner). The other way is also true, namely that the limit amount may be lower than the threshold amount, which means acceptance of greater CCR exposure. Limits with no margin call rule also exist, meaning no additional collaterals at all (non-standard/higher risk requirements usually apply).

CONCLUSIONS

This article covers one of the approaches used to manage counterparty credit risk in the Polish OTC derivatives market in the relationship between financial institutions and non-financial counterparties, namely the application of the pre-settlement risk limits. When applying for treasury limits, enterprises provide banks with specific financial data and information on hedging policy together with risk exposures, and yet various banks prepare different limit amounts for those counterparties and allow them to use different financial instruments. It also happens that within the same institution, a given limit amount is sufficient to cover a specific exposure in one year, and the same exposure at risk requires a different limit amount in another year (due to risk requirements change because of higher market volatility).

The study of selected WSE-listed banks on the CCR rules and credit policy indicates a group of factors directly affecting cooperation conditions for non-financial counterparties in the Polish OTC derivatives market. The research outcome contains a list of key factors affecting the CCR appetite within financial institutions, reflected in the pre-settlement limit amount granted. The breakdown of these determinants relates to (i) the specific instrument planned to conclude, (ii) the given counterparty, (iii) the financial institution and (iv) the regulatory environment. Differences observed and practical implications for market participants are discussed. Due to limited access to data, selected banks were included in the study. Therefore, I recommend conducting a more detailed examination of all entities within the WIG-BANKI index in this regard.

Recognition and analysis of factors determining the limit amount is crucial, particularly for market practice (end-user and financial institutions) and scientists. The institutions carry out constant activities aimed at improving their CCR policy and management system to gain market advantage and attract more derivatives business. Non-financial entrepreneurs benefit from a deeper insight and awareness surrounding practical issues of treasury limits application. Academics may identify practical challenges and address them in their research in order to identify alternative solutions both on theoretical and application grounds.

As a result of the global financial crisis of the early twenty-first century, the area of OTC derivatives is subject to intensive regulatory regulations, particularly interbank operations. Due to the growing importance of transactions with non-financial counterparties, it is not surprising that this area attracts more and more attention (ECB, 2023; FED, 2024), especially since the approach to risk assessment and management is not uniform. Therefore, which path is optimal and should be particularly promoted to strengthen financial stability? A clear answer to this question requires further investigation. Research in this area should aim to recognize and develop best practices in CCR management and governance using derivative instruments to mitigate market risk within treasury limits. The practical challenges concern, for instance, the breaches of contractual terms (events of default), timely renewal of treasury limits, or market risk estimation (models). Interesting subjects are those related to treasury limit utilization schemes, treasury limit setups and collateral types or different margin call policies observed in practice. All these issues require further examination.

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Acknowledgements and Financial Disclosure

The publication was not financed from any sources.

Use of Artificial Intelligence

The text is free of AI/GAI usage.

Conflict of Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Published by Krakow University of Economics – Krakow, Poland

International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.03

A complex phenomenon of students' entrepreneurial potential

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ABSTRACT

Objective: This study extends beyond traditional research focused on entrepreneurial aspirations or cultural factors by proposing a universally applicable model to evaluate the entrepreneurial potential of both local and international students. It also aims to identify the characteristics of students with high entrepreneurial potential. By understanding these capabilities, higher education institutions can create more targeted and effective entrepreneurial education programs.

Research Design & Methods: This study explores the entrepreneurial potential among university students. We collected the data from 1 554 students studying at the University of Information Technology and Management (UITM) in Rzeszów, Poland. The study identifies four basic dimensions of entrepreneurship (creativity, motivation, locus of control, and risk-taking). Thus, its results determine students' 'entrepreneurial potential.' We measured the reliability of the constructed dimensions by Cronbach's alpha coefficient. We implemented a confirmatory factor to confirm the factor structure and assess the model's goodness-of-fit to the data.

Findings: The study identifies statistically significant differences in entrepreneurial potential among diverse demographic groups and backgrounds. It highlights the defining characteristics of entrepreneurial students, offering a comprehensive understanding of the factors that drive student entrepreneurship.

Implications & Recommendations: The research introduces the student entrepreneurial potential scale as a globally applicable tool and thus enables universities to assess and understand the entrepreneurial potential of their student populations. This allows institutions to design customized and impactful entrepreneurial education programs.

Contribution & Value Added: The contribution to the literature is significant because of the UITM's cultural diversity (one-quarter of students are international). The study included various demographic characteristics such as age, employment status, degree level, and country of origin. The comprehensive sample allowed us to create a profile of a student with high entrepreneurial potential. Such a student is typically a 19-21-year-old, studying programming, full-time in English at the undergraduate level, originating from Kazakhstan, China, or India.

Article type:	research article
Keywords:	entrepreneurial potential; students' entrepreneurship; business entry; entrepreneurial decisions; institutional support for entrepreneurship
JEL codes:	L26, M13

Received: 26 July 2024 | Revised: 31 December 2024 | Accepted: 3 January 2025

Suggested citation:
Güneri, S., Mróz, M., Polat, H., & Skica, T. (2025). A complex phenomenon of students' entrepreneurial potential. *International Entrepreneurship Review,* 11(3), 29-64. https://doi.org/10.15678/IER.2025.1103.03

INTRODUCTION

In recent years, the entrepreneurial potential of university students has become a focal point of interest for researchers, educators, and policymakers due to its vital role in driving economic growth, innovation, and the generation of new employment opportunities. Entrepreneurial potential refers to students' ability to identify, develop, and exploit opportunities to create value in various contexts, often with limited resources (Shane & Venkataraman, 2000). This potential is a crucial attribute for preparing future business leaders who can adapt efficiently to a rapidly changing global market environment (Bae *et al.,* 2014; Nabi *et al.,* 2018). While lots of research has focused on the influence of cultural factors or the aspirations of student entrepreneurs, we sought to fill a critical gap by introducing a novel, universally applicable

model for assessing entrepreneurial potential. By developing the student entrepreneurial potential scale, this study provides a new tool that higher education institutions can employ to evaluate and understand entrepreneurial tendencies among their diverse student populations. The dual objective of this research is not only to propose this innovative assessment tool but also to analyze the findings derived from a large, representative sample of university students.

We conducted the research at the University of Information Technology and Management (UITM) in, Poland, using data from 1 554 students, representing 30% of the university's population. The sample was robust and covered a wide range of demographics and academic disciplines to ensure representativeness. The study delved into four core dimensions of entrepreneurial potential: creativity, motivation, locus of control, and risk-taking (Schmitt-Rodermund, 2004). We carefully chose these dimensions to provide a comprehensive understanding of the attributes that drive entrepreneurial behaviour among students. Furthermore, the analysis emphasizes the impact of transformative life experiences – such as moving to a different country or continent for education – on enhancing entrepreneurial potential. This finding adds a unique cultural and experiential perspective to the existing body of knowledge.

The central thesis of this research highlights the complexity of entrepreneurial potential, emphasizing that it is shaped by a confluence of psychological traits, educational experiences, and socio-cultural factors. We meticulously analyzed demographic characteristics such as age, gender, employment status, field of study, mode of study, and country of origin to paint a detailed picture of students who exhibit high entrepreneurial potential. According to the study, these students are typically 19-21 years old, enrolled in full-time, English-language undergraduate programs such as programming, and often come from culturally diverse regions, notably Kazakhstan, China, or India. The results underscore the need for universities to consider both the diversity and specific entrepreneurial traits of their student body when designing education programs. This study contributes to the literature not only due to the size and diversity of the sample but also because of its comprehensive approach, which integrates internal and external factors affecting entrepreneurial potential. The research builds on existing studies by Liñán and Chen (2009), Thornton *et al.* (2011), and Hayton *et al.* (2002) but extends their findings by offering a multidimensional model that emphasizes both individual traits and broader socio-cultural influences. This holistic perspective is crucial for understanding how universities can foster entrepreneurial mindsets across a global student population.

Moreover, the insights from this research have practical implications for higher education institutions worldwide. By leveraging the student entrepreneurial potential scale, universities can identify and nurture entrepreneurial talent more effectively. Understanding students' entrepreneurial characteristics enables the development of personalized, culturally responsive education programs that support entrepreneurial growth. These programs can be tailored to address the unique needs of both local and international students, fostering a supportive environment that enhances entrepreneurial skills and attitudes. Moreover, the research sheds light on the importance of integrating cultural awareness into educational strategies, which is increasingly relevant in today's interconnected academic and professional landscapes (Pittaway & Edwards, 2012; Rideout & Gray, 2013).

The universality and interdisciplinary approach of this study provide a foundation for further research and application. By capturing the entrepreneurial potential across diverse student demographics, the findings offer a valuable resource for educators and policymakers aiming to promote entrepreneurship as a driver of economic and social progress. Thus, this research also contributes to academic literature but also provides actionable insights that can inform the development of strategic initiatives in higher education. By understanding the factors that enhance or inhibit entrepreneurial potential, universities can play a pivotal role in shaping the next generation of innovative leaders (Bae *et al.*, 2014; Shirokova *et al.,* 2016).

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Entrepreneurial potential among young people is a key concept in the entrepreneurship field (Bergmann *et al.*, 2016; Marques & Albuquerque, 2012). Its features encompass multidimensionality, which has a fundamental impact on an individual's ability to identify, pursue and use entrepreneurial oppor-

tunities (Krueger Jr. *et al.*, 2000). This topic, especially in the area of student entrepreneurship, plays a key role in driving economic growth, stimulating innovation and creating new jobs (Liñán & Fayolle, 2015). Therefore, understanding the complexity of entrepreneurial potential among young minds and its components is of fundamental importance to educators, policymakers and practitioners who strive to develop an entrepreneurial mentality and support innovation.

This multidimensionality of entrepreneurial potential highlights various perspectives and components of cultural values and norms. Entrepreneurial skills such as time management, creativity, decision-making, communication and flexibility play a key role in developing and exploiting students' entrepreneurial potential (Kuratko, 2020; Varamäki *et al.,* 2015). To gain a comprehensive understanding of the potential of entrepreneurship among young people (especially students), as well as the outcomes of entrepreneurial endeavours, it is essential to start by exploring different approaches to defining entrepreneurship. This includes examining psychological factors (which focus on internal cognitive and emotional processes), educational aspects (which consider the role of academic training and learning experiences), environmental influences (which encompass the impact of external conditions and resources), and cultural perspectives (which address how cultural norms and values shape entrepreneurial attitudes and behaviours) (Pittaway & Cope, 2007; Isenberg, 2010; Hofstede *et al.*, 2004).

The psychological approach provides a basis for understanding entrepreneurial potential by highlighting traits, cognitive processes, and motivations that shape entrepreneurial behaviour. Researchers like Baron (2006), DeNisi (2015), and Brandstätter (2011) indicate that creativity, risk-taking, and having an internal locus of control are key traits of successful entrepreneurs. These individuals are willing to take calculated risks, think creatively, and have confidence in their ability to impact outcomes. Rauch and Hulsink (2017) add that traits like openness to experience and resilience are also important, emphasizing how personality and motivation work together to influence entrepreneurial actions.

Emotional intelligence is another important factor in the psychological approach. According to Baron and Tang (2011), being able to understand and manage emotions helps people develop and sustain their entrepreneurial potential. Furthermore, passion drives people to stay committed and push through challenges. Zhao and Seibert (2006) suggest that both emotional and cognitive processes are important, as they shape how entrepreneurs think and act beyond just specific skills or interests.

Entrepreneurial intentions (*i.e.*, the plans and goals to start a business) are also crucial. These intentions can turn into real actions, known as entrepreneurial behaviour, but this process depends on confidence and support from the environment (Belchior & Lyons, 2021; Salmony & Kanbach, 2022). The Theory of Planned Behavior (TPB), as explained by Feola *et al.* (2019), shows how attitudes, norms, and perceived control influence intentions. However, as Shi *et al.* (2020) note, self-efficacy and supportive conditions are necessary for these intentions to lead to action. Lihua (2022) highlights that confidence, or self-efficacy, is key to making sure intentions turn into behaviour.

Batz Liñeiro *et al.* (2024) show that motivations, whether based on opportunities or necessity, affect how one realizes entrepreneurial potential. Opportunity-driven entrepreneurs are generally more proactive and likely to succeed.

Overall, the psychological approach to understanding entrepreneurial potential focuses on traits, emotions, and thought processes that influence how people act. It also highlights the importance of self-confidence and supportive environments in helping people turn their entrepreneurial plans into reality. This perspective shows that both personal traits and external support are key to developing entrepreneurial potential in young people.

Another approach to entrepreneurial potential is based on the educational aspect. Entrepreneurship theories in this area focus on the impact and role of learning environments, curricula, their design, and pedagogical strategies. An important element in understanding the educational approach to entrepreneurial potential is its holistic nature. This approach aims not only to provide theoretical knowledge about business or economic activity but also to enhance individuals' practical skills. When applied, these skills combine behaviours, competencies, and motivations that significantly influence the ability to start one's own business (Rasmussen & Sørheim, 2006). We may see this also in the research by Fayolle and Gailly (2008) and Pittaway and Cope (2007), who assume that

there is a relationship between well-selected and appropriately designed teaching programs and an individual's ability to undertake entrepreneurial activities.

According to Galloway *et al.* (2006), experiential learning, mentoring, interdisciplinary courses, or training are some of the best solutions for cultivating an entrepreneurial mind and entrepreneurial mentality. Research shows that this approach to learning, where the emphasis is on social networks and practice, provides young people with greater support while increasing their chances for entrepreneurial success. We may see similar results in the work of Henry *et al.* (2005), which explores whether entrepreneurship can effectively be taught by engaging students in practical business experiences. Similarly, Solomon *et al.* (2002) highlight the role of the educational environment in promoting creativity and entrepreneurship through hands-on learning opportunities such as case studies, business simulations, and apprenticeships. Bygrave and Zacharakis (2014) further advocate for integrating modern educational tools like e-learning platforms and virtual simulations to enhance the effectiveness of educational planning processes.

The above-mentioned educational methods and tools aim to develop an educational approach to the potential of entrepreneurship by encouraging students to think independently, search for solutions, think creatively and critically, and make decisions in conditions of uncertainty. This is extremely important because contemporary entrepreneurial education must also consider dynamic changes in the business environment and innovations, such as new technologies. These theories regarding adapting to changes and facing adversities are confirmed in Valencia-Arias *et al.* (2022). Their research underscores the importance of integrating training within the educational process, particularly in essential skills like problem-solving and interpersonal communication. This educational approach to entrepreneurial potential extends beyond knowledge transmission to encompass the cultivation of skills, attitudes, and motivation essential for effective navigation in contemporary business environments. It involves diverse activities aimed at fostering an entrepreneurial mindset, equipping students to tackle future challenges and seize business opportunities.

The penultimate area considered in the context of the approach to entrepreneurial potential is the environment. When describing the environmental approach to entrepreneurial potential, we must define the environment itself. It concerns more than family and education. According to Edewor *et al.* (2014), we should also consider it through structural, social, cultural, and economic factors. According to the above, the first component of the environmental approach to entrepreneurial potential is structural factors. Among them, the availability of technological infrastructure, and in more recent studies also, ecological infrastructure, as well as a network of suppliers and business factors, are important for the development of student entrepreneurship. The analysis of economic components shows primarily the importance of financial support. A very important element of the development of entrepreneurship among young people is a flexible approach to credit conditions, microfinance, support throughout the entire financing process and, above all, appropriate availability (Henry *et al.,* 2005).

Research indicates that the environment influences critical factors that shape entrepreneurial ventures (Taormina & Lao, 2007). External stimuli and resources, and therefore, favourable conditions, highly stimulate entrepreneurial behaviour, especially in terms of executive activities. Due to young age, the closest environment that shapes young people is educational environments and family. A study conducted by Carr and Sequeira (2007) shows that growing up in an entrepreneurial family significantly influences the behaviour of individuals and develops their entrepreneurial potential. This happens by generating a supportive environment. To sum up, the literature suggests that the family plays a key role in shaping students' entrepreneurial potential through role models, emotional support and cultural norms (Osorio *et al*., 2017; Farrukh *et al*., 2017).

The last element of the environment shaping entrepreneurial potentialise social factors. They play a crucial role in influencing entrepreneurial potential, especially through the support offered by social capital. It is important to recognize that conducive social environments are essential for fostering entrepreneurship among young people.

Social factors, mentioned as the final key element in the environmental approach to entrepreneurial potential, are an integral part of cultural stimuli. This is because cultural factors significantly influence entrepreneurial aspirations and behaviours (Autio *et al.*, 2001; Urbano *et al.*, 2011; Singh *et al.*,

2017). Particularly in aspects such as social support, social and cultural contexts, these elements have a crucial impact on actively undertaking entrepreneurial actions and are reflected in entrepreneurial behaviours such as risk-taking and openness to innovation (Liñán & Fayolle, 2015; Guerrero & Urbano, 2018). However, social norms and cultural values can also negatively affect the development of entrepreneurial potential among young people. They may not only promote but also inhibit entrepreneurship development by influencing the social acceptance of such activities and shaping expectations regarding success and social status (Thornton *et al.*, 2011). For instance, in regions where entrepreneurship, especially the inclination towards risk-taking and innovation, is not socially accepted or positively perceived, entrepreneurial potential, behaviours, and active efforts towards its development may be constrained (Guerrero & Urbano, 2018; Morris *et al.*, 2017; Stephan & Uhlaner, 2010).

The basic distinctions between the promotion and inhibition of entrepreneurship in relation to cultural factors are the two main patterns according to which individuals identify with the social environment: individualism and collectivism (Liñán *et al.*, 2016). In an individualistic culture, the emphasis is on the individual, his or her independence, and self-control. People in such cultures are proud of their achievements and motivated by their own interests and the pursuit of personal goals. Hofstede (1980) defines individualism as emotional independence from 'groups, organizations, or other collectivities.' In such societies, people often perceive entrepreneurship as a path to personal development and achieving financial independence (Arenius & Minniti, 2015). They may also treat it as a path to success and social prestige. Young people growing up in such an environment are much more open to choosing such a career. However, societies with collectivistic tendencies, where the value of community and cooperation are emphasized, may manifest a more conservative approach to entrepreneurship (Liñán & Fayolle, 2015). In such cultures, individuals may prefer the stability and security of employment within the company over the risks associated with running their own business. Collectivism is characterized by strong bonds in groups that protect them throughout their lives in exchange for unconditional loyalty. Such societies avoid and prefer known solutions that serve the masses. Entrepreneurship in such an environment may signal risk and uncertainty (Hofstede, 1980; Morris, 2019). Young people in such environmental conditions may be less willing to take risks related to entrepreneurial initiatives.

Consequently, the cultural approach may have a significant impact on the development of students' entrepreneurial potential. This is because one must consider all four (psychological, educational, environmental, and socio-cultural) of the aforementioned approaches, which ascertain the potential of entrepreneurship and their intertwined interplay. Moreover, scholars should consider educational migrations a phenomenon as they not only generate interpersonal or intercultural interactions but also, when viewed individually, influence new experiences and challenges (Autio *et al.*, 2013). Studying outside the home country can influence a young person's entrepreneurial potential as a result of being exposed to a new reality, a different language and culture (Lackéus, 2020). These factors determine the main approaches to entrepreneurial potential (Zvarikova & Kacerauskas, 2017; Mueller & Thomas, 2001). Thanks to the influence of these factors, and especially the ensuing environmental change, young people are exposed to cultural and economic diversity, which directly promotes the growth of competences such as creativity, adaptability, stress resistance and decision-making flexibility, as well as the ability to take risks and innovate. Here, the influence of the educational approach is also extremely important because international exchanges, participation in programs, internships and other forms of educational activities create real opportunities to acquire potential business partners who can be a key link in the use of entrepreneurial potential (Rialp *et al.*, 2005). Research has also confirmed that entrepreneurial potential can be developed through various educational and professional experiences (Shane & Venkataraman, 2000).

Therefore, we may hypothesize that the impact of psychological, environmental, social, and cultural factors on university students' entrepreneurial potential varies based on demographic and cultural contexts. Considering the above, we formulated two research hypotheses:

H1: Demographic factors influence students' entrepreneurial potential.

H2: Cultural factors influence students' entrepreneurial potential.

This study includes both local and international students who experience the same academic programs, teaching methods, and living conditions within a shared social, cultural, and economic environment. However, these influences might be less pronounced compared to the stronger effect these factors would have if the students were immersed in their home countries and native environments.

The literature recognizes entrepreneurial potential as a dynamic concept primarily shaped by external influences and specific situations (Hunter, 2013; Bruyat & Julien, 2001). To address this, the present research extends beyond traditional studies of student entrepreneurship by utilizing a comprehensive framework that assesses entrepreneurial potential through four key sub-dimensions: creativity, motivation, locus of control, and risk-taking. This innovative and expansive method significantly contributes to the field by offering a universally applicable assessment model, which universities can adopt globally. By implementing this methodology, we aimed to evaluate the extent to which the identified factors affect the entrepreneurial potential of both local and international students, as discussed in the literature review.

RESEARCH METHODOLOGY

Sample

We collected the data through an online survey administered to 1 864 students from the University of Information Technology and Management in Rzeszów, Poland. After excluding 305 questionnaires that did not meet the expected criteria or contained incomplete responses, we conducted the final analysis on 1 554 valid questionnaires. The survey utilized an original questionnaire developed by the research team in collaboration with economists, a sociologist, and a psychologist. The research encompassed 21 fields of study, both in Polish and English, including bachelor's and master's programs, as well as full-time and part-time students. We employed G-Power software, a widely used tool for determining sample size to ensure sufficient statistical power, to calculate an adequate sample size for detecting medium-sized effects across an average of five groups (Kang, 2021). Based on the G-Power results, we deemed a sample size of 305 individuals sufficient. However, to enhance the sample representativeness, we ensured that the study included at least 20% of students from each field, ultimately covering approximately 30% of the total student population at UITM. Table 1 presents the key characteristics of the research sample.

Study Design

We applied a cross-sectional online to gather insights into the perspectives of students enrolled at the University of Information Technology and Management in Rzeszów, Poland. We aimed to assess various aspects of students' entrepreneurial potential and verify their interest in starting a business (including assistance in this regard from the university) in various fields of study, including both bachelor's and master's studies, as well as full-time and part-time studies. We selected a representative sample from UITM, including students from 21 fields of study offered at the university, covering both Polish and English language programs. Furthermore, we made efforts to maintain the proportionality of students from each field, with a minimum representation of 20% per field. We used our own original survey questionnaire. The questionnaire form included demographic information and 28 five-class Likert items measuring student entrepreneurial potential, and a section with multiple-choice statements about forms of business support expected by students. We selected a large and representative sample size of 1 554 students. We completed the study without any conflicts of interest. We considered ethical principles while doing the research and writing the article.

Before the surveys, to comply with ethical guidelines and to protect participants' confidentiality and privacy, we reviewed Order No. 61/2023, issued by the Rector of the University of Information Technology and Management in Rzeszów on June 29, 2023, on changes to the regulations of the Committee for Ethics of Scientific Research. We adapted the study concept and the conduct method to the guidelines of the above Order. Based on the analysis of the cited legal act, we determined that neither the subject of the research nor the participants covered by it require additional, formal consent from the Committee to conduct it.

Table 1. Demographic characteristics of participants

Demographic Characteristics		*f*	*%*
Age	16-18	156	10.0%
	19-21	627	40.2%
	22-24	486	31.2%
	25-30	180	11.5%
	31-40	91	5.8%
	>41	19	1.2%
Employment status	Full-time employee	431	27.6%
	Part-time employee	239	15.3%
	Unemployed	450	28.9%
	Freelancer	82	5.3%
	Self-employed	86	5.5%
	Trainee/apprentice	96	6.2%
	Economically inactive	175	11.2%
Mode of study	Stationary	903	57.9%
	Non-stationary	656	42.1%
Track of study	English	252	16.2%
	Polish	1307	83.8%
Country of origin	Poland	1149	73.7%
	Ukraine	223	14.3%
	Kazakhstan	53	3.4%
	China	3	0.2%
	India	7	0.4%
	Belarus	19	1.2%
	Other[a]	105	6.7%
Level of study	Bachelor	1319	84.6%
	Master	240	15.4%

Note. [a] Kazakhstan, China, India, Belarus and Other (Spain, Türkiye, Slovenia, and African countries like Zimbabwe)
Source: own study.

Data Analysis

We analysed quantitative data collected through the survey using a variety of statistical techniques. We calculated the descriptive statistics, including measures of central tendency (*e.g.,* mean) and variability (*e.g.,* standard deviation), to summarize the basic characteristics of the research sample and key survey variables. We performed an independent sample t-test to examine differences between two groups on continuous variables, such as comparing the mean scores of full-time and part-time students on entrepreneurial potential. We utilized analysis of variance (ANOVA) to assess differences among multiple groups on continuous variables. We performed exploratory factor analysis (EFA) to explore the underlying factor structure of the survey instrument and identify latent constructs representing different dimensions of the students' perceptions. We also applied confirmatory factor analysis (CFA) to confirm the factor structure identified through EFA and evaluate the goodness-of-fit of the proposed model to the observed data. Finally, we used Cronbach's alpha coefficients to check for the reliability of the scale. We accepted the significance level as 5% (p: 0.05) during the hypothesis testing, we used IBM SPSS 28™ and Lisrel 8.5™.

Research Strategy and Scale Development Process

Because the scale used in this research is grounded in Caird's (1991) study, we deemed unnecessary a pilot study to evaluate the conceptual validity (Hair, 2009). The scale's prior validation in similar contexts provided sufficient confidence in its appropriateness for the current study. However, the reliability and validity tests used to perform the scale showed that the compatibility of the existing factor

structure with the sample was not satisfactory. To solve this problem, we adopted the strategy of conducting an exploratory method using the existing item pool. Firstly, the data underwent a cleaning process to identify missing values and outliers to ensure they met the assumptions of factor analysis. Secondly, we conducted principal component analysis-based EFA to identify factors with retention decisions based on eigenvalues, scree plot, and interpretability. We analysed factor loadings, communalities, and correlations with rotation methods and evaluated them for clearer interpretation. In the third step, we developed a hypothesized model based on EFA results and theory and tested its fit with CFA. We assessed the model fit using indices. We also made modifications based on these indices and theoretical considerations. We then reassessed reliability and validity. Table 2 presents EFA results.

Table 2. Items descriptive statistics and reliability test results of factor structure with factor loads

Variable	Mean	SD	Corrected item-total correlation	Cronbach's alpha if item was deleted	Factor loads of EFAs rotated component Matrix
Dimension I Reliability: 0.873					
a6	4.34	0.765	0.566	0.863	0.694
a7	4.09	0.864	0.501	0.868	0.676
a10	3.98	0.806	0.552	0.864	0.673
a13	4.22	0.762	0.532	0.865	0.647
a14	4.11	0.840	0.580	0.862	0.632
a18	4.15	0.818	0.642	0.858	0.628
a19	4.21	0.738	0.640	0.859	0.597
a20	4.17	0.859	0.618	0.859	0.555
a21	3.79	0.908	0.481	0.869	0.542
a22	4.37	0.769	0.639	0.858	0.513
a25	3.85	0.943	0.622	0.859	0.512
Dimension II Reliability: 0.807					
a1	3.55	1.046	0.631	0.757	0.788
a2	3.50	1.012	0.566	0.785	0.781
a16	3.45	1.323	0.666	0.739	0.711
a17	3.26	1.250	0.651	0.744	0.670
Dimension III Reliability: 0.744					
a3	3.89	1.014	0.528	0.691	0.703
a4	3.80	0.996	0.531	0.689	0.652
a11	3.70	0.914	0.561	0.674	0.609
a12	3.92	0.946	0.533	0.688	0.605
Dimension IV Reliability: 0.559					
a8	2.40	1.237	0.297	0.578	0.671
a15	3.10	1.058	0.423	0.511	0.626
a23	3.70	1.146	0.294	0.577	0.612
a26	3.13	1.222	0.380	0.531	0.580
a28	2.96	1.040	0.397	0.525	0.572
Total reliability (Cronbach's alpha) = 0.824					
Excluded items = a5, a9, a24, a27					
Rotation method = Varimax with Kaiser Normalization.					
Extraction method = Principal Component Analysis. **Kaiser-Meyer-Olkin measure of sampling adequacy =** 0.918 **Approximately Chi-square ($\chi_{(276)}^2$)of Bartlett's test of sphericity =** 12.640.67 (p<.001). **Total variance explained of 4 factors =** 50.39%					

Source: own study.

The results indicate that there was a 4-dimension factor structure that can explain our scale. According to Table 2, the variance explanation ratio for the four factors was 50.15%. Moreover, the Kaiser-Meyer-Olkin measure of sampling adequacy points that our sample size was sufficient, and

Bartlett test of sphericity indicated that the observed correlations were significantly different (χ^2 = 12.640, df = 67, p < 0.05).

According to the results, we can claim that the 1st, 2nd, and 3rd dimensions had high reliability, and the 4th dimension had sufficient reliability. The factor loadings, all but 2 factor loadings (a8: 0.297 and a23: 0.294) were above 0.3. As these two items were very close to 0.3 and their removal from the scale had a limited effect on the reliability of the 4th dimension, we decided to keep them in the scale, considering Hair's suggestions (Hair, 2009) and remove a5, a9, a24, a27 items as they did not provide sufficient factor loadings from the scale.

As a result of the reliability and exploratory analyses, we decided that the four-factor structure was appropriate for our scale. Thus, we applied a CFA to test the validity of the new scale structure. Below, we share the results (Table 3).

Table 3. CFA fit indices results

Criteria	Fit Indices	Good Values	Acceptable Values
RMSEA	0.053	0 ≤ RMSEA ≤ 0.05	0.05 ≤ RMSEA ≤ 0.08
χ2/df	2.16	0≤ χ2/sd≤2	0≤ χ2/sd≤3
SRMR	0.049	0 ≤ SRMR ≤ 0.05	0.05 ≤ SRMR ≤ 0.10
NFI	0.95	0.95 ≤ NFI ≤ 1.00	0.90 ≤ NFI ≤ 0.95
GFI	0.90	0.95 ≤ GFI ≤ 1.00	0.90 ≤ GFI ≤ 95
AGFI	0.88	0.90 ≤ AGFI ≤ 1.00	0.85 ≤ AGFI ≤ 0.90
PGFI	0.74	0.95 ≤ PGFI ≤ 1.00	0.50 ≤ PNFI ≤ 0.95
CFI	0.97	0.95 ≤ CFI ≤ 1.00	0.90 ≤ NFI ≤ 0.95
RFI	0.94	0.95 ≤ RFI ≤ 1.00	0.90 ≤ RFI ≤ 0.95
df=246, χ2 =531.76, 90 Percent Confidence Interval for RMSEA (0.047:0.059) N=1.559			

Note: **RMSE:** Root mean squared errors, **GFI:** goodness of fit index, **NFI:** Normed fit index, **CFI:** Comparative fit index, **SRMR:** Standardized root mean errors, **PCFI:** Parsimony goodness of fit index, **RFI:** Relative fit index

Source: own study.

According to Table 3, fit indices for factor structure were good and acceptable values (Schumacker & Lomax, 2004). Figure 1 presents a PATH diagram of CFA.

As illustrated in Figure 1, no factor load was less than 0.3. These findings demonstrate that the revised factor structure met the reliability and validity requirements. Creativity is necessary for entrepreneurs because entrepreneurship requires innovation. Creativity is considered one dimension of an 'enterprising mindset' that includes improving creativity, innovativeness, ability to see and determine opportunities, and putting ideas into practice. When an entrepreneur enters a market, they use creativity to create an image for the business, create a customer portfolio, manage resources effectively, produce innovative goods and/or services or innovatively produce them, and earn a sufficient market share (Holienka *et al.*, 2015). Creative people are typically 'imaginative, innovative, curious, and versatile' (Caird, 1991). In today's competitive business world, these qualities are deemed necessary to start a business since every entrepreneur is flexible and innovative in thinking while generating many good quality ideas.

Locus of control is another dimension of entrepreneurial potential. Locus of control is a tool for understanding human behaviour. Galvin *et al.* (2018) describe the locus of control as 'the degree to which individuals perceive they control events and outcomes in their lives and how those beliefs shape affect, cognition, and behaviour' (Galvin *et al.*, 2018). When individuals feel that they make things happen, their behaviours and traits affect results then they have an internal locus of control, whereas when they attribute events to external factors, they have an external locus of control (Galvin *et al.*, 2018). Individuals with an internal locus of control are believed to have more entrepreneurial characteristics such as 'insight, initiative, achievement, assertion, independence, effectiveness, sociability or intellectual efficiency' (Caird, 1990).

Risk-taking is an important feature of entrepreneurs. In most cases, no gain or less gain than expected may be made without taking any risks. However, this behaviour can depend on a particular situation that is possibly rewarding (Holienka *et al.*, 2015). Risk-taking is 'the ability to deal with incomplete information and act on a risky option that requires skill to analyse challenging but realistic goals'

(Caird, 1991). Risk-taking, also expressed as the propensity to take risks, is a characteristic that requires control and calculation. Too much risk can be harmful to individuals' lives and careers. On the other hand, starting a business involves a certain degree of risk.

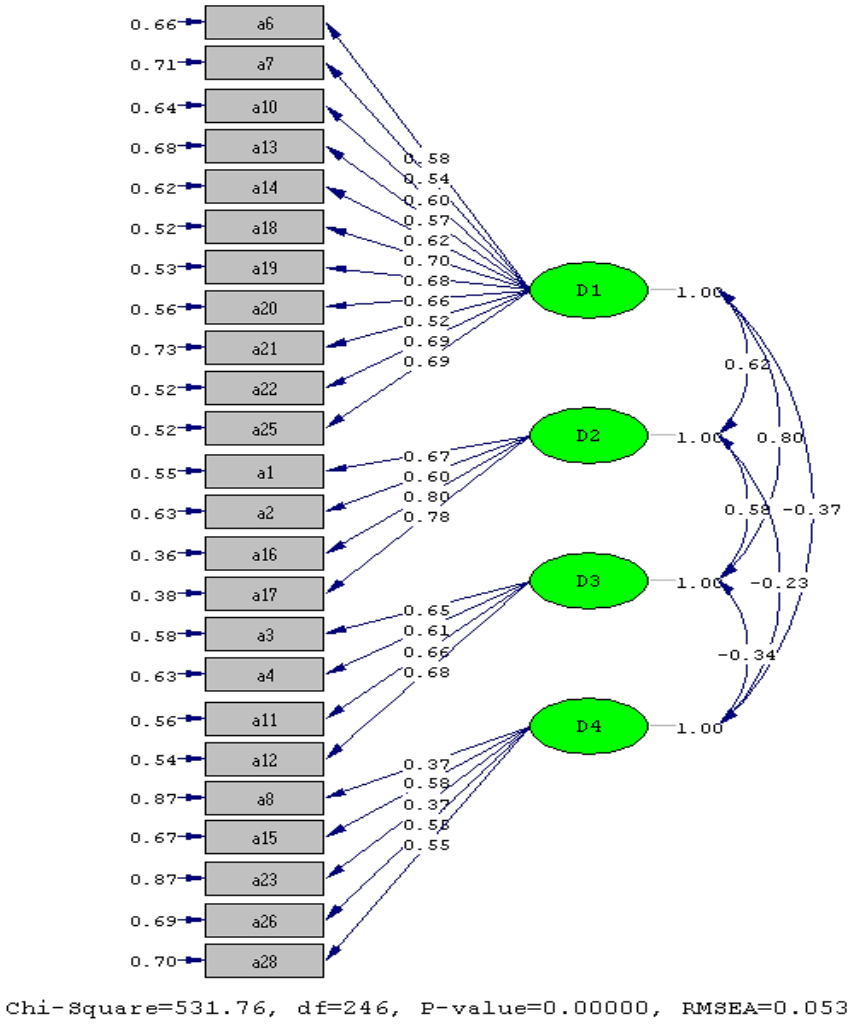

Figure 1. PATH diagram of CFA
Source: own elaboration.

We built these four dimensions of student entrepreneurship on different groups of questions. We developed them from the questions' averages. On top of these four dimensions, we derived from data a fifth-dimensional entrepreneurial potential (also the scale name), which is the 'upper dimension.' We developed this scale from the mean of all the questions of the survey. It includes all four dimensions. We assumed that the students with high entrepreneurial potential displayed creativity, motivation, locus of control, and risk-taking.

RESULTS AND DISCUSSION

Table 4 presents the descriptive statistics, including the mean and standard deviation, for the factors obtained in the previous section. Moreover, it includes the skewness and kurtosis values for convergence to a normal distribution.

According to the descriptive statistics table, the skewness and kurtosis values of the dimensions were in the ±1 range. In this case, it was appropriate to perform parametric tests under the assumption that the data converge to normal distribution. Noteworthy, we excluded the fifth survey from the analysis due to the presence of outliers, resulting in a new sample size of 1554.

Table 4. Descriptive Statistics

Dimensions	Minimum	Maximum	Mean	Std. D.	Kurtosis	Skewness
Creativity	20.00	55.00	45.398	5.730	-0.594	0.502
Motivation	4.00	20.00	13.796	3.678	-0.319	-0.522
Locus of control	4.00	20.00	15.338	2.854	-0.718	0.660
Risk-taking	19.00	35.00	27.207	2.935	0.008	-0.072
Entrepreneurial potential	**52.00**	**120.00**	**89.842**	**9.931**	**-0.183**	**0.452**

Note: N:1554 (5 surveys was excluded after outlier analysis).
Source: own study.

Table 5. Experiences of participants related to business activity

Characteristics		n	%
Do you run a business, or are you a shareholder in a company?	Yes	195	12.5%
	No	1364	87.5%
Do you plan to start a business while studying at UITM?	Definitely disagree	287	21.0%
	Rather disagree	400	29.3%
	Neither agree or disagree	428	31.4%
	Rather agree	178	13.0%
	Definitely agree	71	5.2%
Have you ever used UITMs support in setting up and running a business?	Yes	53	3.4%
	No	1506	96.6%

Source: own study.

Table 5 provides data on respondents' business-related activities and intentions. Regarding current business involvement, 12.5% of respondents indicated they either ran a business or held shares in a company, while the majority (87.5%) did not. When asked about plans to start a business while studying at UITM, responses varied 21.0% definitely disagreed, 29.3% rather disagreed, 31.4% neither agreed nor disagreed, 13.0% rather agreed, and 5.2% definitely agreed. In terms of utilizing UITM's support for business setup and operation, only a small fraction (3.4%) of respondents reported having used UITM's support, while the majority (96.6%) had not.

In the literature on entrepreneurial potential, there is a widely accepted assumption that both personality (including psychological) and environmental factors affect entrepreneurial potential (Galloway & Kelly, 2009). Cultural factors play a key role here. The results of the study indicate that a small portion of respondents participated in entrepreneurial activities and intended to start a business during their university education. Table 14 (See in the Appendix) provides insights into respondents' utilization and perception of support offered by UITM for setting up businesses by students. According to Table 14, only a small percentage of respondents utilized UITM's support services, with most indicating they did not use the support offered by the university. Respondents most commonly utilized 'support in preparing a business plan' (1.2%). A similarly low percentage of respondents (between 2.1% and 3.1%) utilized other services, such as financial and accounting support, legal support, participation in thematic training courses for entrepreneurs, support in obtaining external funding, and support in developing product and marketing strategies. On the other hand, the primary reason for not using UITM's support was a lack of awareness about the availability of such support (60.8%). The survey results showed that an important portion (60.8%) of the respondents had no awareness of the support for setting up a business offered by the university. This fact partially shows that we did not use the right channels to reach students. Despite not utilizing UITM's support previously, a significant portion of respondents expressed interest in taking advantage of start-up and business assistance offered by UITM again (40.9%). Respondents expressed varying expectations from UITM's support services, including assistance in preparing business plans, financial and accounting advice, legal advice, direct financial support, participation in thematic training courses, support in business model development,

assistance in choosing organizational and legal forms of business activity, assistance in business registration procedures, assistance in obtaining funds, and the opportunity to consult business ideas with practitioners. Reasons for not planning to use UITM's support services included not finding the university's support offer attractive (13.0%), needing financial support not available from the university (9.9%), preferring to keep business ideas confidential (9.2%), reluctance to have obligations toward the university (20.4%), having more confidence in external experts (4.5%), having had negative experiences with university support applications (1.9%), dissatisfaction with the university's support meeting expectations (0.6%), and finding better-suited services from other market players (4.1%). According to Galloway and Kelly (2009), before giving entrepreneurial support to students and, therefore, revealing and developing their entrepreneurial potential, it is necessary to understand the reasons for their participation in entrepreneurship education. Then, it will be possible to increase students' entrepreneurial potential and support them as an institution. While defining a structure of entrepreneurial potential, Galloway and Kelly (2009) mentioned that the 'most entrepreneurial' end of the spectrum contains practical interest, then goes with interest as a potential, broad interest in enterprise and associated skills, and no choice. The spectrum ends with the 'least entrepreneurial.' Entrepreneurship support aims to take the students who are not in the most entrepreneurial end to the most entrepreneurial end. Lu *et al.* (2021) also found that students are reluctant to receive entrepreneurship support from their universities. The authors suggest that this reluctance is due to additional entrepreneurial support, lack of student control over the content of the support, the university considering students as a homogeneous group in terms of entrepreneurship, and very high expectations of students regarding entrepreneurship support. In his cross-country comparative analysis, Trivedi (2016) found that the willingness of students to receive entrepreneurship support at universities is not directly related to individualism-collectivism cultural aspects. Thus, mostly individual and institutional factors affect students' willingness to receive support from their universities. From the institution's perspective, the institution should offer personalized entrepreneurship support, not considering every student the same, *i.e.*, developing a personalized approach and students' feedback should constitute part of the consideration. By doing the right things, universities can raise students' entrepreneurship motivation and develop and reveal their entrepreneurial potential. Individually, students' interest and entrepreneurial potential, namely creativity, locus of control, motivation, and risk-taking play role significant role in shaping their intention to receive entrepreneurship support.

Table 6 shows the results of an independent t-test examining the impact of changing cultural factors on business motivation based on gender.

Table 6. Group statistics and t-test results for gender

Dimension	Gender	N	Mean	Std. Deviation	Test stat.	Sig.
Creativity	Female	766	45.219	5.635	-1.210	0.226
	Male	788	45.571	5.820		
Motivation	Female	766	13.910	3.485	1.206	0.228
	Male	788	13.685	3.855		
Locus of control	Female	766	15.087	2.858	-3.430	0.001*
	Male	788	15.582	2.831		
Risk-taking	Female	766	27.218	2.850	0.152	0.880
	Male	788	27.195	3.017		
Entrepreneurial potential	Female	766	89.510	9.668	-1.297	0.195
	Male	788	90.164	10.176		

Source: own study.

Based on the significance values in Table 6, it appears that there is no statistically significant difference between the entrepreneurial potential levels of men and women, with a 95% confidence level ($t_{(1552)}$:-1.297; $p>0.05$). The results of the test in terms of sub-dimensions prove that only the locus of control sub-dimension shows a statistically significant difference between men and women ($t_{(1552)}$:-3.430; $p<0.05$). The findings confirm the results of some other researchers. According to

Veličković *et al.* (2022), there is no statistically significant difference between female and male students who want to start a business. However, women generally want to wait for a longer time to start their business and realize their aspirations. Galloway *et al.* (2006) also indicate that female business owners have perception bias such that they are less likely to consider themselves entrepreneurs than male business owners. A higher locus of control may explain differences between students (women and men) planning to start a business. To make it clear, we may observe the locus of control difference between genders in the waiting behaviour of women to start a business and their perception bias. Similarly to this study's findings, Franco *et al.* (2010) and Ward *et al.* (2019) also found no difference between genders in terms of entrepreneurial potential.

ANOVA is a statistical method used to analyse the differences among group means in a sample. It is particularly useful when comparing the means of three or more groups to determine if there are statistically significant differences between them (Hair, 2009). This method enabled testing whether there was a statistically significant difference in the entrepreneurship potentials of students across different age groups who participated in the survey. Table 7 shows the results of ANOVA according to age.

Table 7. Group statistics and ANOVA results for age

Variables / Age		N	Mean	Std. D	F Stat.	Sig
Creativity	16-18	156	45.256	5.626	1.785	0.129
	19-21	625	45.163	5.732		
	22-24	484	45.281	5.681		
	25-30	179	46.000	5.988		
	31-40	110	46.464	5.571		
	Total	1554	45.398	5.730		
Motivation	16-18	156	13.936	3.555	0.755	0.554
	19-21	625	13.686	3.675		
	22-24	484	13.738	3.586		
	25-30	179	14.196	3.909		
	31-40	110	13.827	3.883		
	Total	1554	13.796	3.678		
Locus of control	16-18	156	15.679	2.635	7.303	0.000*
	19-21	625	15.158	2.861		
	22-24	484	15.031	2.866		
	25-30	179	16.056	2.818		
	31-40	110	16.064	2.797		
	Total	1554	15.338	2.854		
Risk-taking	16-18	156	27.615	3.173	4.688	0.001*
	19-21	625	27.342	2.915		
	22-24	484	27.283	2.863		
	25-30	179	26.542	2.817		
	31-40	110	26.600	2.999		
	Total	1554	27.207	2.935		
Entrepreneurial Potential	16-18	156	90.840	9.741	1.275	0.278
	19-21	625	89.477	9.897		
	22-24	484	89.490	9.774		
	25-30	179	90.698	10.389		
	31-40	110	90.655	10.264		
	Total	1554	89.842	9.931		

Note: Age group 41+ has been merged with 31-40 due to fewer than 30 members.
Source: own study.

The ANOVA results indicated that there was no statistically significant difference in the motivation level of age groups with a 95% confidence level ($F_{(4;1549)}$:1.275; p>0.05). No difference among the age groups regarding entrepreneurial potential implies that individuals can become entrepreneurs at every age. Franco *et al.* (2010) also found that there is no statistically significant difference between age

groups and entrepreneurial potential. According to Bolton and Thompson (2004), 'While entrepreneurship is possible at any age, the true entrepreneur is likely to do it sooner rather than later.' A young person in their 20s can attempt to start a business, but the first attempt or a few attempts may fail. That also can be a factor in raising the average age of entrepreneurs. However, this process is valuable as it increases the chances of the person becoming an entrepreneur (Timmons & Spinelli, 2007). According to sub-dimensions locus of control ($F_{(4;1549)}$:7.303; $p<0.05$) and risk-taking ($F_{(4;1549)}$:4.688; $p<0.05$) have shown significant differences through age groups. Llewellyn (2003) found that a high locus of control is a common personality trait of entrepreneurs. Rauch and Frese (2007) also indicated that high locus of control and risk propensity are the personality traits that an entrepreneur is likely to have. The findings of this study reveal that age groups 25-30 and 31-40 had the highest

Table 8. Group statistics and ANOVA results for employment status

Variables / Employment status		N	Mean	Std. D	F Stat.	Sig
Creativity	Full-time employee	429	45.427	5.793	10.380	<.001
	Part-time employee	238	46.008	5.977		
	Unemployed	449	45.434	5.509		
	Freelancer	82	44.988	6.133		
	Self-employed	86	48.907	4.253		
	Trainee/apprentice	95	44.526	5.323		
	Economically inactive	175	43.343	5.543		
	Total	1554	45.398	5.730		
Motivation	Full-time employee	429	13.650	3.487	29.374	<.001
	Part-time employee	238	14.118	3.700		
	Unemployed	449	13.724	3.476		
	Freelancer	82	14.390	3.562		
	Self-employed	86	17.884	2.177		
	Trainee/apprentice	95	13.232	3.263		
	Economically inactive	175	11.920	3.839		
	Total	1554	13.796	3.678		
Locus of control	Full-time employee	429	15.506	2.818	9.392	<.001
	Part-time employee	238	15.529	2.868		
	Unemployed	449	15.292	2.650		
	Freelancer	82	15.317	2.918		
	Self-employed	86	16.814	2.369		
	Trainee/apprentice	95	15.126	2.643		
	Economically inactive	175	14.189	3.293		
	Total	1554	15.338	2.854		
Risk-taking	Full-time employee	429	27.054	2.919	3.639	0.001*
	Part-time employee	238	27.555	2.881		
	Unemployed	449	27.359	2.943		
	Freelancer	82	26.537	3.206		
	Self-employed	86	26.267	3.647		
	Trainee/apprentice	95	27.074	2.687		
	Economically inactive	175	27.566	2.460		
	Total	1554	27.207	2.935		
Entrepreneurial Potential	Full-time employee	429	89.699	10.047	17.557	<0.001
	Part-time employee	238	91.387	10.285		
	Unemployed	449	89.893	9.399		
	Freelancer	82	89.268	9.749		
	Self-employed	86	97.709	7.305		
	Trainee/apprentice	95	88.000	8.906		
	Economically inactive	175	85.360	9.548		
	Total	1554	89.842	9.931		

Source: own study.

locus of control. However, the two groups had low scores in risk-taking, but the 16-18 group had the highest score. In terms of average entrepreneur age, the results confirmed that people become entrepreneurs in their mid-30s. In terms of entrepreneurial potential, it is possible to indicate that personality traits are more effective in determining it than age groups.

Table 8 presents ANOVA results regarding employment status. Through this analysis, it is possible to assess whether there was a statistically significant difference in the entrepreneurial potentials among students with varying employment statuses.

Table 8 indicates a statistically significant difference in entrepreneurial potential based on employment status ($F_{(6;1547)}$:17.557; $p<0.05$) according to the sub-dimensions. We made the distinction among categories of employment status following Labour Force Survey Statistics Poland. Within that distinction, full-time employees work for 40 hours a week, part-time employees work 20 hours a week, unemployed people are registered at the district labour office and are looking for a job, and economically inactive people do not work or do not look for a job (stat.gov.pl). In addition to these categories, the Careers Service of UITM indicated the need to extend the metrics to include freelancers who work without a full-time job, perform tasks on commission, are self-employed and run their businesses, and trainees/apprentices who are a student doing a paid/unpaid internship or work placement. The findings regarding employment status reveal no surprising picture of the high average entrepreneurial potential score of self-employed people. We observe that self-employed people possess more features of creativity, motivation, and locus of control. However, in risk-taking, self-employed people show no outstanding value. This shows that self-employed people are creative, motivated, and have an internal locus of control that makes them proactive, but when it comes to risks, they take calculated risks and protect themselves from high risks. In their study, Bayraktaroglu and Kutanis (2015) found that the 'propensity to take risk' scores of entrepreneurs are 10% higher than the scores of non-entrepreneurs among MBA students. This finding shows that a big gap may not exist between entrepreneurs and non-entrepreneurs in terms of risk. Koh (1996) indicates that the characteristics that differentiate the entrepreneur from the non-entrepreneur are their entrepreneurial values, attitudes, and needs. However, some research emphasized the need to achieve goals as a feature of an entrepreneur. According to McClelland (1961), this 'achievement motivation' is an entrepreneurial characteristic supported by the findings of this study. Accordingly, the 'motivation' score of self-employed people is the highest among those of all the employment statuses.

Since all the sub-dimensions exhibit statistically significant differences, it is possible to conclude that members of all the groups can have different levels of these four sub-dimensions. This result implies that all employment statuses require separate analyses to elaborate on their true entrepreneurial sets of characteristics.

Table 9 presents the results of the independent sample t-test comparing the entrepreneurial potential of the participants according to the study mode.

Table 9. Group statistics and t-test results for study mode

Dimension	Study Mode	N	Mean	Std. Deviation	Test stat.	Sig.
Creativity	Stationary	901	45.552	5.751	1.244	0.214
	Non-stationary	653	45.185	5.700		
Motivation	Stationary	901	13.848	3.782	0.654	0.513
	Non-stationary	653	13.724	3.530		
Locus of control	Stationary	901	15.471	2.821	2.146	0.032*
	Non-stationary	653	15.156	2.891		
Risk-taking	Stationary	901	27.269	2.929	0.979	0.328
	Non-stationary	653	27.121	2.943		
Entrepreneurial Potential	Stationary	901	90.285	10.052	2.070	0.039*
	Non-stationary	653	89.230	9.738		

Source: own study.

Based on the significance values presented in Table 9, we observed a statistically significant difference between the entrepreneurial potential levels of different study modes, with a 95% confidence

level ($t_{(1552)}$:2.070; p<0.05). The test results indicated that only the locus of control sub-dimension exhibited a statistically significant difference among study modes ($t_{(1552)}$:2.146; p<0.05). These findings revealed that the entrepreneurial potential of students with a stationary study mode was higher than the ones with a non-stationary mode. Furthermore, their locus of control was higher. Staniewski and Szopinski (2015) found that the interest of part-time university students in starting their own business is higher than that of full-time university students. However, they state that the relationships were weak due to the low T-Chuprow coefficient. It is a dependency coefficient used to measure the strength of the relationship between two nominal variables with values in the range [0.1]. The closer the value of the t coefficient is to 1, the stronger the relationship between the examined features. In their study, Safiullin and Akhmetshin (2019) examined entrepreneurial skills development through distance learning. They found that 72% of entrepreneurs were full-time graduates, and 28% were extramural graduates. Moreover, 48% of distance learning students did not feel ready to start a business. All these findings imply that students with stationary mode generally have more entrepreneurial potential, although some students with non-stationary mode may also have it.

Table 10. Group statistics and t-test results for track of study

Dimension	Track of Study	N	Mean	Std. Deviation	Test stat.	Sig.
Creativity	English	252	47.786	5.809	7.350	<0.001
	Polish	1302	44.935	5.601		
Motivation	English	252	15.032	3.993	5.458	<0.001
	Polish	1302	13.557	3.566		
Locus of control	English	252	16.440	2.647	6.793	<0.001
	Polish	1302	15.125	2.844		
Risk-taking	English	252	27.266	3.339	0.315	0.753
	Polish	1302	27.195	2.851		
Entrepreneurial Potential	English	252	94.567	11.122	8.437	<0.001
	Polish	1302	88.927	9.418		

Source: own study.

According to the test results presented in Table 10, there was a statistically significant difference between the entrepreneurial potential levels among different study tracks, with a 95% confidence level ($t_{(1552)}$:8.437; p<0.05). Creativity, motivation, and locus of control sub-dimensions showed statistically significant differences between tracks of study level ($t_{(1552)}$:2.146; p<0.05). Noteworthy, the overwhelming majority of students studying in English were international students, and the overwhelming majority of students studying in Polish were Polish and Ukrainian students. From a cultural point of view, the results of the study regarding the nationalities of the respondents had research implications. According to Hofstede *et al.* (2004), economic factors alone cannot fully explain the tendency towards entrepreneurship. That's why cultural factors require examination. Hofstede (1980) defined the concepts of individualism and collectivism to categorize general cultural tendencies. Societies dominated by individualism often view entrepreneurship as a path to personal development and achieving financial independence (Arenius & Minniti, 2015). Therefore, the citizens of these countries are expected to reveal more entrepreneurship potential. Meanwhile, in societies dominated by collectivism, entrepreneurship is commonly associated with risk and uncertainty (Hofstede, 1980; Morris, 2019). Thus, the citizens of these countries are expected to be distant and hesitant towards entrepreneurship. The study results reveal that students receiving education in English have more entrepreneurial potential than students receiving education in Polish. Students studying in English mostly come from Kazakhstan, China, India, and Belarus. These countries are dominated by collectivism. Among those countries, the individualism score of only Belarus is as high as Poland and Ukraine, while that of other countries is typically collectivist (www.theculturefactor.com). These results imply that individualism level is not a determinant of entrepreneurial potential in this study. Thus, other factors have been influential. Apart from the entrepreneurial potential dimensions, the desire for new experiences and challenges, a new country, a new reality, different environments, and cultural and economic diversity can directly

promote the growth of competencies such as creativity, adaptability, stress resistance, and decision-making flexibility, as well as the ability to take risks and innovate (Guerrero & Urbano, 2018). These factors explain the difference between the entrepreneurial potential of the two groups of students coming from individualist countries and collectivist countries. Students receiving education in English have more entrepreneurial potential due to these factors but not individualism-collectivism cultural factors. Dimensions of entrepreneurial potential also reveal the same result that students receiving education in English have more entrepreneurial potential. The risk-taking dimension alone does not show any statistically significant differences. Just like students receiving education in English, Polish and Ukrainian students also have the risk-taking ability and motivation to start a business. We used ANOVA to test whether there was a statistically significant difference in the entrepreneurial potential of students with differing countries of origin. Table 11 shows ANOVA results according to country of origin.

Table 11. Group statistics and ANOVA results for country of origin

Variables / Countries		N	Mean	Std. D	F Stat.	Sig
Creativity	Poland	1145	44.832	5.648	43.488	<0.001
	Ukraine	222	45.333	5.358		
	Other[a]	187	48.936	5.414		
	Total	1554	45.398	5.730		
Motivation	Poland	1145	13.442	3.567	31.616	<0.001
	Ukraine	222	14.032	3.556		
	Other	187	15.684	3.902		
	Total	1554	13.796	3.678		
Locus of control	Poland	1145	14.994	2.912	38.899	<0.001
	Ukraine	222	15.878	2.397		
	Other	187	16.807	2.406		
	Total	1554	15.338	2.854		
Risk-taking	Poland	1145	27.234	2.854	0.601	0.549
	Ukraine	222	27.009	2.747		
	Other	187	27.273	3.578		
	Total	1554	27.207	2.935		
Entrepreneurial Potential	Poland	1145	88.609	9.618	57.878	<0.001
	Ukraine	222	90.414	8.516		
	Other	187	96.711	10.544		
	Total	1554	89.842	9.931		

[a]Kazakhstan, China, India, Belarus, and others(Spain, Türkiye, Slovenia, and African countries like Zimbabwe)
Source: own study.

According to Table 11, there was a statistically significant difference in entrepreneurial potential across different countries of origin ($F_{(6, 1551)} = 57.878$, $p < 0.05$). Moreover, sub-dimensions creativity, motivation, and locus of control also exhibited statistically significant differences by country of origin ($p < 0.05$). In Table 15, the countries are divided into three categories, namely Poland, Ukraine, and others. This categorization explains the fact that countries belonging to the third group (*i.e.,* Kazakhstan, China, India, Belarus, and others) create a separate category of countries, considered through the prism of business motivation. As stated above, international students are also expected to have more entrepreneurial potential than Polish and Ukrainian students as they leave their comfort zones. We may interpret the results in this category also as the effect of the study category. We may explain it by the desire for new experiences and challenges, a new country, a new reality, different environments, and cultural and economic diversity that can directly promote the growth of competencies such as creativity, adaptability, stress resistance, and decision-making flexibility, as well as the ability to take risks and innovate (Guerrero & Urbano, 2018). The sub-dimension risk-taking again does not reveal any statistically significant difference, and this state confirms the results exhibited in Table 12 regarding the study track. Risk-taking is more of a personality trait, and any student may have it. In this part of the study, we used an independent

sample t-test to investigate the differences in students' entrepreneurship potentials according to their education level. Below, we present the results according to the level of study (Table 12).

Table 12. Group statistics and t-test results for the level of study

Dimension	Level of Study	N	Mean	Std. Deviation	Test stat.	Sig.
Creativity	Bachelor	1316	45.424	5.693	0.426	0.670
	Master	238	45.252	5.942		
Motivation	Bachelor	1316	13.842	3.677	1.158	0.247
	Master	238	13.542	3.677		
Locus of control	Bachelor	1316	15.337	2.853	-0.060	0.952
	Master	238	15.349	2.867		
Risk-taking	Bachelor	1316	27.201	2.910	-0.164	0.870
	Master	238	27.235	3.074		
Entrepreneurial Potential	Bachelor	1316	89.895	9.905	0.499	0.618
	Master	238	89.546	10.091		

Source: own study.

The test results indicated that there was no statistically significant difference between the entrepreneurial potential and sub-dimensions according to the level of study. Findings by Popescu *et al.* (2016) support this finding. They also found that there is no statistically significant difference between the entrepreneurial potential of bachelor's and master's students. They just found that bachelor's students are more inclined to take risks regarding entrepreneurial activities. The researchers mentioned that as students get older and become master's students, their risk propensity falls (Popescu *et al.*, 2016). The finding of no differences between levels of study is consistent with the finding of 'no differences' between age groups. This study reveals that as people mature, their entrepreneurial potential does not increase or decrease. Some students may be very active in their bachelor's education in researching entrepreneurship opportunities due to the excitement brought by their young age. However, as they mature and start their master's program, they continue to do so as they are more aware of entrepreneurship's importance. This relates to the education they have received.

Below, we present ANOVA results comparing the entrepreneurial potentials of the students participating in the survey according to the field of study (Table 13).

Table 13 presents the mean and standard deviation for entrepreneurial potential according to students' field of study. The F-statistic indicates a statistically significant difference in creativity scores among the field of study ($F_{(15.1532)} = 7.247$, $p< 0.05$). On the other hand, the F-statistic shows a statistically significant difference in motivation scores ($F_{(15.1532)} = 10.229$, $p < 0.05$), locus of control ($F_{(15.1532)} = 7.221$, $p < 0.05$), risk-taking ($F_{(15.1532)} = 3.506$, $p < 0.05$), and entrepreneurial potential scores ($F_{(15.1532)} = 9.882$, $p < 0.05$). The highest entrepreneurial potential scores were those for programming, sustainability, and the environment, biomedicine, graphic design, and management students. This finding is consistent with that of Galloway and Kelly (2009). They found that business and science (including IT) students have high entrepreneurial potential. The results of this study exhibit that programming students have the highest motivation and locus of control scores, Holienka *et al.* (2015) support with their findings that applied informatics students have the tendency to invent innovative solutions. On the other hand, biomedicine students' high entrepreneurial potential requires support from serious entrepreneurship education because in the biotechnology industry, a high level of entrepreneurial effort is needed since product approval is scientifically complex, takes a very long time (typically 10 to 15 years), and requires very big budgets (Gunn, 2016). Holienka *et al.* (2015) found that business administration students have the highest entrepreneurship tendency, and psychology, applied informatics, and pedagogy students follow them. Regarding business administration and programming-informatics, the findings of Holienka *et al.* (2015) and those of this study are parallel to each other. Apart from designing a general entrepreneurship education, universities should also determine the fields of study that do not support entrepreneurship and give support to the students of these departments. In that case, department-specific entrepreneurship education will facilitate students' revealing their entrepreneurial potential.

Table 13. Group statistics and ANOVA results for the field of study

Variables / Study fields		N	Mean	Std. D.	F stat	Sig.
Creativity	Biomedicine	64	49.188	4.676	7.247	<0.001
	Computer game design	46	46.000	4.794		
	Computer graphics and multimedia production	61	45.066	5.677		
	Cybersecurity	35	44.029	6.618		
	Digital Marketing	52	46.288	5.214		
	English Philology with Chinese	114	43.447	5.932		
	Graphic design	148	46.324	5.716		
	Logistics	125	44.992	5.063		
	Management	141	45.312	4.914		
	Nursing	248	44.488	5.860		
	Other	61	43.984	7.184		
	Physiotherapy	40	45.600	5.453		
	Programming	57	49.614	4.898		
	Psychology in management	169	44.663	5.469		
	Sustainability and the environment	55	47.745	5.605		
	Sustainable development in the economy	117	45.034	5.770		
	Total	1533	45.397	5.748		
Motivation	Biomedicine	64	14.859	3.919	10.229	<0.001
	Computer game design	46	14.304	3.418		
	Computer graphics and multimedia production	61	13.344	3.405		
	Cybersecurity	35	12.886	3.787		
	Digital Marketing	52	13.615	3.922		
	English Philology with Chinese	114	12.588	3.579		
	Graphic design	148	14.297	3.585		
	Logistics	125	13.048	3.353		
	Management	141	14.475	2.973		
	Nursing	248	12.851	3.737		
	Other	61	13.410	3.422		
	Physiotherapy	40	14.525	3.523		
	Programming	57	16.982	2.918		
	Psychology in management	169	14.740	2.997		
	Sustainability and the environment	55	15.782	4.175		
	Sustainable development in the economy	117	12.385	3.899		
	Total	1533	13.808	3.672		
Locus of con-trol	Biomedicine	64	16.813	2.122	7.221	<0.001
	Computer game design	46	15.261	2.245		
	Computer graphics and multimedia production	61	14.557	2.896		
	Cybersecurity	35	14.571	3.567		
	Digital Marketing	52	16.000	2.842		
	English Philology with Chinese	114	14.439	3.275		
	Graphic design	148	15.919	2.594		
	Logistics	125	14.944	3.033		
	Management	141	15.801	2.343		
	Nursing	248	15.008	3.002		
	Other	61	15.262	2.798		
	Physiotherapy	40	15.075	2.712		
	Programming	57	17.105	2.257		
	Psychology in management	169	14.580	2.878		
	Sustainability and the environment	55	16.800	2.824		
	Sustainable development in the economy	117	15.359	2.332		
	Total	1533	15.344	2.859		

Variables / Study fields		N	Mean	Std. D.	F stat	Sig.
Risk-taking	Biomedicine	64	26.641	3.234	3.506	<0.001
	Computer game design	46	27.130	2.933		
	Computer graphics and multimedia production	61	27.361	2.858		
	Cybersecurity	35	26.514	3.364		
	Digital Marketing	52	25.365	3.260		
	English Philology with Chinese	114	27.658	2.862		
	Graphic design	148	26.595	2.740		
	Logistics	125	27.176	2.600		
	Management	141	27.652	2.691		
	Nursing	248	27.665	3.093		
	Other	61	26.902	2.725		
	Physiotherapy	40	27.350	2.607		
	Programming	57	27.509	3.581		
	Psychology in management	169	27.012	2.502		
	Sustainability and the environment	55	28.109	3.218		
	Sustainable development in the economy	117	27.034	2.874		
	Total	1533	27.196	2.929		
Entrepre-neurial potential	Biomedicine	64	95.516	9.825	9.882	<0.001
	Computer game design	46	90.522	7.577		
	Computer graphics and multimedia production	61	88.656	10.524		
	Cybersecurity	35	86.114	10.981		
	Digital Marketing	52	89.077	9.318		
	English Philology with Chinese	114	86.386	10.342		
	Graphic design	148	91.027	8.785		
	Logistics	125	88.200	9.255		
	Management	141	91.241	8.335		
	Nursing	248	88.310	10.146		
	Other	61	87.787	10.490		
	Physiotherapy	40	90.550	8.884		
	Programming	57	99.070	10.149		
	Psychology in management	169	89.089	8.753		
	Sustainability and the environment	55	96.509	11.860		
	Sustainable development in the economy	117	88.034	8.921		
	Total	1533	89.843	9.951		

Source: own study.

CONCLUSIONS

This study provided an in-depth evaluation of the entrepreneurial potential among students at the University of Information Technology and Management in Rzeszów, Poland, using unique survey tools developed by the Department of Entrepreneurship. The research utilized a comprehensive and culturally diverse sample, encompassing over 30% of the university's students, with representation across all fields of study.

This robust approach ensured that the findings were reflective of the entire student population at UITM. The study's significant contribution lies in the large, diverse sample of 1 554 students and the cultural diversity of UITM, where around one-quarter of the students are international. By incorporating various demographic characteristics such as age, employment status, mode of study, degree level, and country of origin, this research developed a detailed profile of a student with high entrepreneurial potential. Results indicate that this typical student is between 19 and 21 years old, studies programming full-time in English at the undergraduate level, and hails from regions like Kazakhstan, China, or India.

As revealed in this study, psychological, environmental, educational, social, and cultural factors influence entrepreneurship potential. The research model employed four key dimensions, *i.e.,* creativity, motivation, locus of control, and risk-taking, which provided a comprehensive view of entrepre-

neurial potential. The findings suggest that students from outside Poland, particularly those studying in English-language programs, exhibit higher entrepreneurial potential. The experience of relocating to a different country and integrating into a new social and educational environment fosters traits such as creativity, motivation, risk-taking, and an appropriate locus of control, which are crucial for entrepreneurship.

The study also highlighted that entrepreneurial potential varies significantly based on cultural distance. For instance, students from countries geographically and culturally distant from Poland, such as Kazakhstan, China, and India, display higher entrepreneurial potential compared to those from Ukraine, where cultural and situational differences are less pronounced. These findings underline the need for universities to recognize and leverage these variations to cultivate entrepreneurial talent effectively.

From an educational standpoint, understanding the entrepreneurial potential of students is vital for designing impactful curricula and support systems. Higher education institutions (HEIs) can use the developed tool to tailor their entrepreneurial education programs, fostering skills and attitudes that align with their students' entrepreneurial profiles. Despite being limited to one university in Poland, this research lays the groundwork for broader international studies that could involve larger, more geographically dispersed samples and a greater diversity of influencing factors. Future research should aim to extend this analysis to other academic institutions and explore additional demographic variables to further enhance our understanding of student entrepreneurship.

The practical implications of this study are substantial. Higher education institutions can implement routine and voluntary surveys to measure the entrepreneurial potential of students, even beyond the university level to high school and secondary education, thereby designing relevant educational strategies. The study suggests that universities could adopt research-oriented, consulting, or practice-based models of entrepreneurial education tailored to their students' needs (Varblane *et al.,* 2008). Furthermore, HEIs could create comprehensive support systems to measure and nurture entrepreneurial skills, including scholarship programs that incentivize entrepreneurial initiatives.

On the policy front, this research provides valuable insights for educational authorities. Governments and educational institutions could promote entrepreneurship education, ensuring it becomes a standard component across universities. Policymakers might also consider developing training programs tailored to graduates' intended industries, equipping them with the entrepreneurial skills necessary for professional success.

From a managerial perspective, the findings offer opportunities for businesses to incorporate entrepreneurial potential assessments into their hiring practices. Companies could use modified versions of the survey tool to evaluate the entrepreneurial tendencies of prospective employees, thereby fostering a culture of 'entrepreneurship.' Furthermore, organizations could design training programs to identify and nurture entrepreneurial talent within their workforce, driving innovation and growth from within.

In conclusion, this study offers a valuable framework for understanding and measuring student entrepreneurial potential while acknowledging its limitations. Focusing on a single institution limited the generalizability of the findings. Nevertheless, the study confirmed both the first hypothesis that demographic factors influence students' entrepreneurial potential and the second hypothesis that cultural factors influence students' entrepreneurial potential, as results clearly demonstrate that demographic and cultural backgrounds play a significant role in shaping entrepreneurial potential among students. Future research should aim to replicate this study in different cultural and institutional contexts, considering additional demographic variables and employing a more balanced, international sample. Such research would further validate the tool's efficacy and broaden its applicability, contributing to the global discourse on entrepreneurship education.

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Appendix 1:

Table 14. Expectation's entrepreneurship support offered by UITM

Items		n	%
What was the support provided by UITM about? [Support in preparing a business plan]	Yes	18	1.2%
	No	35	2.2%
	NA	1506	96.6%
What was the support provided by UITM about? [Financial and accounting support]	Yes	15	1.0%
	No	38	2.4%
	NA	1506	96.6%
What was the support provided by UITM about? [Legal support]	Yes	20	1.3%
	No	33	2.1%
	NA	1506	96.6%
What was the support provided by UITM about? [Participation in thematic training courses for entrepreneurs]	Yes	15	1.0%
	No	38	2.4%
	NA	1506	96.6%
What was the support provided by UITM about? [Support in obtaining external funding for starting a business]	Yes	15	1.0%
	No	38	2.4%
	NA	1506	96.6%
What was the support provided by UITM about? [Support in developing a product strategy]	Yes	11	0.7%
	No	42	2.7%
	NA	1506	96.6%
What was the support provided by UITM about? [Support in developing a marketing strategy]	Yes	5	0.3%
	No	48	3.1%
	NA	1506	96.6%
If you did not use the support offered by UITM when setting up your business, what was the reason? [I was not aware that such support was available]	Yes	948	60.8%
	No	558	35.8%
	NA	53	3.4%
If you did not use the support offered by UITM when setting up your business, what was the reason? [I had no need for the support offered by the university]	Yes	599	38.4%
	No	907	58.2%
	NA	53	3.4%
If you did not use the support offered by UITM when setting up your business, what was the reason? [I think that the market offers better support than the university]	Yes	50	3.2%
	No	1456	93.4%
	NA	53	3.4%
If you did not use the support offered by UITM when setting up your business, what was the reason? [I did not know who / which units at the university to approach for support]	Yes	255	16.4%
	No	1251	80.2%
	NA	53	3.4%
If you did not use the support offered by UITM when setting up your business, what was the reason? [I did not want the support provided to create future obligations towards the university]	Yes	115	7.4%
	No	1391	89.2%
	NA	53	3.4%
If you did not use the support offered by UITM when setting up your business, what was the reason? [I needed financial support, which I could not get from the university]	Yes	54	3.5%
	No	1452	93.1%
	NA	53	3.4%
Are you interested in taking advantage of the start-up and business assistance offered by UITM again?	Yes	637	40.9%
	No	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Assistance in the preparation of a business plan]	Yes	353	22.6%
	No	284	18.2%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Financial and accounting advice]	Yes	366	23.5%
	No	271	17.4%
	NA	922	59.1%

What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Legal advice]	Yes	349	22.4%
	No	288	18.5%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Direct financial support from UITM]	Yes	217	13.9%
	No	420	26.9%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Participation in thematic training courses]	Yes	255	16.4%
	No	382	24.5%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Support in the development of a business model]	Yes	224	14.4%
	No	413	26.5%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Assistance in choosing the organisational and legal form of business activity]	Yes	204	13.1%
	No	433	27.8%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Assistance in the procedure of registering business activity]	Yes	261	16.7%
	No	376	24.1%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Assistance in obtaining funds for starting business activity]	Yes	276	17.7%
	No	361	23.2%
	NA	922	59.1%
What kind of support do you expect from UITM when setting up a business, taking into account your experience to date with support from the University? [Possibility to consult business ideas with practitioners]	Yes	260	16.7%
	No	377	24.2%
	NA	922	59.1%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [I do not think that the university has an attractive offer of support]	Yes	203	13.0%
	No	719	46.1%
	NA	637	40.9%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [I need financial support, which I will not get at university]	Yes	154	9.9%
	No	768	49.3%
	NA	637	40.9%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [I don’t want too many people to know about my business idea]	Yes	143	9.2%
	No	779	50.0%
	NA	637	40.9%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [I don’t want to have obligations towards the university]	Yes	318	20.4%
	No	604	38.7%
	NA	637	40.9%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [I have more confidence in external experts]	Yes	70	4.5%
	No	852	54.7%
	NA	637	40.9%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [I have had bad experiences with applying for university support]	Yes	30	1.9%
	No	892	57.2%
	NA	637	40.9%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [The support provided by the university has not met my expectations]	Yes	9	0.6%
	No	913	58.6%
	NA	637	40.9%
If you do not plan to use UITMs support when setting up your business, what are the reasons for this? [Services provided by other market players meet my needs better]	Yes	64	4.1%
	No	858	55.0%
	NA	637	40.9%

Note. *NA: not available.

Source: own elaboration.

Appendix 2:

Survey on Student Entrepreneurial Potential and Forms of Business Support Expected by Students

The staff of the Department of Entrepreneurship at UITM in Rzeszów, Poland, are conducting research on the potential for entrepreneurship among students and the forms of support from the University that students planning to start a business expect. Answers to the questions in the survey are anonymous. The results will be used to develop solutions aimed at effectively supporting those planning to set up a business. We hope for honest and comprehensive answers. Incomplete questionnaires will not provide full knowledge of the topic under investigation. The survey will take no longer than 10 minutes to complete.

Thank you for completing the survey.

(A) Student Entrepreneurial Potential (In each question, please only choose one response)

A1. I am an entrepreneurial person

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A2. My family and friends consider me an entrepreneurial person

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A3. I consider myself a person of strong character

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A4. In stressful situations I can concentrate and think clearly

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A5. I am a person who never gives up

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A6. The setbacks I experience provide me with lessons for the future

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A7. My life is determined by my own actions

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A8. To what extent do you agree with the statement that you are either naturally good at something or you are not; effort makes no difference

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A9. To what extent do you agree with the statement that being successful is a result of working hard and luck has nothing to do with it

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A10. In difficult and complex situations, I always find a few alternatives to solve the problem

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A11. I can find myself in any, even in the most unfavourable circumstances

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A12. I can easily adapt to new circumstances

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A13. I am able to look at a situation from different points of view

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A14. I like to find out about things, even if it means handling some problems while doing so

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A15. I prefer doing things in the usual way rather than trying out new ways

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A16. I am seriously thinking about starting a business

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A17. I am ready to do anything to become an entrepreneur

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A18. I make a determined effort to achieve the goals I set for myself

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A19. I try to cope with solving problems no matter how difficult they are

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A20. Dealing with difficult situations strengthens and develops me

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A21. I implement developed plans from start to finish

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A22. I am open to new experiences

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A23. I would not mind routine, unchallenging work if the pay was good

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A24. When I am faced with a challenge, I think more about the results of succeeding than the effects of failing

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A25. I like to take on challenges that allow me to prove myself in new situations

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A26. I tend to be pessimistic and overly cautious in difficult situations

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A27. Before making an important decision, I prefer to weigh up the pros and cons fairly quickly rather than spending a long time thinking about it

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

A28. If there is a chance of failure, I would rather not do it

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

(B) Expectations entrepreneurship support offered by UITM (For each question, choose only one response)

B1. Do you run a business, or are you a shareholder in a company? (If 'No,' go to question B2; if 'Yes,' go to question B3)

a) Yes
b) No

B2. Do you plan to start a business while studying at UITP?

a) Definitely agree
b) Rather agree
c) Neither agree or disagree
d) Rather disagree
e) Definitely disagree

B3. Have you ever used UITMs' support in setting up and running a business? (If 'Yes' go to question B4 and then B6, if 'No' go to question B5)

a) Yes
b) No

B4. What was the support provided by UITM about?

a) support in preparing a business plan
b) financial and accounting support
c) legal support
d) participation in thematic training courses for entrepreneurs
e) support in obtaining external funding for starting a business
f) support in developing a product strategy
g) support in developing a marketing strategy
h) Other, which

B5. If you did not use the support offered by UITM when setting up your business, what was the reason?

a) I was not aware that such support was available
b) I had no need for the support offered by the university
c) I think that the market offers better support than the university
d) I did not know who / which units at the university to approach for support
e) I did not want the support provided to create future obligations towards the university
f) I needed financial support, which I could not get from the university
g) Other, which

B6. Are you interested in taking advantage of the start-up and business assistance offered by UITM again? (If 'Yes,' go to question B7. If 'No,' go to question B8).

a) Yes
b) No

B7. What kind of support do you expect from UITM when setting up your business, taking into account your previous experience with support from the University?

a) assistance in the preparation of a business plan
b) financial and accounting advice
c) legal advice
d) direct financial support from UITM
e) participation in thematic training courses
f) support in the development of a business model
g) assistance in choosing the organizational and legal form of business activity
h) assistance in the procedure of registering business activity
i) assistance in obtaining funds for starting a business activity
j) possibility to consult business ideas with practitioners
k) Other, which

B8. If you do not plan to use UITMs support when setting up your business, what are the reasons for this?

a) I do not think that the university has an attractive offer of support
b) I need financial support, which I will not get at university
c) I don't want too many people to know about my business idea
d) I don't want to have obligations towards the university
e) I have more confidence in external experts
f) I have had bad experiences with applying for university support
g) The support provided by the university has not met my expectations
h) Services provided by other market players meet my needs better
i) Other, which

(C) METRICS

C1. Gender:

a) Female
b) Male

C2. Age:

a) from 16 to 18
b) from 19 to 21
c) from 22 to 24
d) from 25 to 30
e) from 31 to 40
f) from 41 and above

C3. Employment status:

a) full-time employee
b) part-time employee
c) unemployed
d) freelancer
e) self-employed
f) trainee/apprentice
g) economically inactive

C4. Mode of study:

a) Offline
b) Online

C5. Track of study:

a) Polish-Language
b) English-Language

C6. Country of Origin:

a) Poland,
b) Ukraine,
c) Kazakhstan,
d) China,
e) India,
f) Belarus,
g) Other, which

C7. Level of study:

a) Bachelor
b) Master
c) Postgraduate

C8. Field of Study:

a) Aviation Management
b) Computer science
c) Social Work
d) Game Design and Development
e) International Business Management
f) Nursing
g) Programming
h) Global Aviation Management
i) Cybersecurity
j) Data Science

Thank you for filling in the questionnaire

Authors

The contribution share of authors is equal and amounted to 25% for each of them. The order of authors is given alphabetically. S. Guneri – literature review, discussion of results and their linkage with the literature. M. Mróz – conceptualization of the study, literature review, discussion of results. H. Polat – preparation of the methodological part, conducting data analysis, and discussion of the obtained results. T. Skica – study conceptualization, research tool development, conducting the research, theoretical and empirical development of the collected source material.

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Acknowledgements and Financial Disclosure

The authors would like to thank the anonymous referees for their useful comments, which allowed to increase the value of this article.

Use of Artificial Intelligence

The authors confirm that the text of the manuscript was prepared entirely without the use of any AI/GAI tools.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Published by Krakow University of Economics – Krakow, Poland

International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.04

Analysis of the circular management model of information and communication technology resources of large enterprises in the European Union

Małgorzata Sztorc, Konstantins Savenkovs

ABSTRACT

Objective: The aim of this article is to determine the level of differentiation of large enterprises operating in the European Union in terms of the sustainable use of information and communications technology tools and to reduce the dimension of variables describing the circular model of managing information and communications technology solutions.

Research Design & Methods: We used quantitative analysis, considering secondary data from the Eurostat database for 2022 from the information and communications technology (ICT) and the environment by the size class of the enterprise section. We conducted a pilot study using data from large enterprises from 27 European Union countries. We analysed data using the diagnostic-descriptive method, principal component analysis, MOORA method, and linearly ordered object grouping.

Findings: The research results indicate that large enterprises represent different levels of circularity in the use of green IT/ICT related to the selection, use, and disposal of devices. Most entities operating in 18 European Union countries achieve an average level of circularity of ICT devices. Thus far, they have not included the reuse of ICT devices in the procedure consistent with the 3R circularity principle. The process of selecting, recovering, and recycling ICT equipment is carried out unevenly and in stages. On the other hand, the indicator of pro-environmental involvement displays low intensity, and in such a situation, the surveyed entities did not achieve the strategic goals assumed by the European Union in the field of circular economy regarding the selection and use of ICT equipment.

Implications & Recommendations: The research results enable managers to develop circular business models by reducing the consumption of raw materials, waste, greenhouse gas emissions, and energy. They support strategic decisions on the transition from a linear model of ICT equipment management to a circular model. They also support European Union policymakers in developing legal regulations aimed at closing material and energy loops. Moreover, they provide guidance on the allocation of financial support to improve the level of circularity of large enterprises.

Contribution & Value Added: The article makes a significant contribution to the development of the circular economy theory by developing an original indicator of pro-environmental involvement in the process of selecting ICT equipment and conducting a comprehensive analysis of circularity in the management of ICT devices in large enterprises of the European Union. The conducted research reveals significant differences in the implementation of the principles of the circular economy in the countries studied, constituting a starting point for further actions to improve efficiency and transfer best practices in this area.

Article type:	research article
Keywords:	circular economy; sustainable development; information and communication technologies; green IT/ICT; MOORA method
JEL codes:	M15, O44, F64

Received: 19 August 2024 | Revised: 30 January 2025 | Accepted: 4 February 2025

Suggested citation:

Sztorc, M., & Savenkovs, K. (2025). Analysis of the circular management model of information and communication technology resources of large enterprises in the European Union. *International Entrepreneurship Review,* 11(3), 65-92. https://doi.org/10.15678/IER.2025.1103.04

INTRODUCTION

Contemporary changes in the business environment have a fundamental impact on its functioning. The environment is under the influence of many phenomena related mainly to the ongoing process of globalization of markets, increasing competition, rapid flow of information, and rapid and intensive development of new information and communication technologies (ICT). Together with the abolition of trade and political and economic barriers, the above circumstances oblige managers to implement immediate and effective actions related to the adaptation of entities to current market conditions. For this reason, it is necessary to introduce appropriate economic models together with action programs that will meet the requirements of the VUCA and BANI environment[1] (Kok, 2018; Ramakrishnan, 2021) and challenges conditioned by, among others, the climate crisis, energy crisis, global warming, improper exploitation and natural resources use.

Despite the increasing devastation of the natural environment, most economies in the world are based on the traditional linear model of business operations. In this type of economy, natural resources are reduced and the volume of waste produced increases. This type of material circulation pattern in the economy is subject to unfavourable assessment because it is impossible to subordinate it to the designated principles of sustainable development (SD). Therefore, it is necessary to transform economies in the scope of more efficient use of natural resources, reduction of pollutant and gas emissions, mitigation and adaptation to climate change in accordance with the SD concept using environmentally friendly information and communication techniques and technologies. An alternative solution to the linear method of resource use, which is replaced by a closed loop of material flow, is the concept of the circular economy (CE). Its main assumption is the use of reverse material flow with simultaneous negligible management of natural resources at minimal costs resulting from actions taken in the field of environmental protection and related to the impact on the environment (Agyapong *et al.*, 2024).

Nowadays, the key role of ICT technology is indicated in the process of minimizing the negative impact of enterprises on the natural environment. Nevertheless, according to the estimates, this sector generates several per cent of global greenhouse gas emissions. From the perspective of implementing the circular model in enterprises, it is important to use ecological solutions in the field of ICT (so-called green IT/ICT), which consist of the appropriate design, production, selection, use, and disposal of such equipment effectively and rationally, slowing down or limiting to zero the impact on the natural environment. Thus, the circular model of managing ICT devices allows reductions in the use of hazardous materials in the production of computer equipment, the selection and design of energy-saving, environmentally friendly devices, and improving energy efficiency during the production life cycle (Nath & Agrawal, 2020). Therefore, the key assumption of the conducted analyses is to find an answer to the research question:

RQ: To what extent do large enterprises in the European Union implement the principles of the circular economy during the life cycle of ICT equipment?

The main objective of the article is to determine the level of differentiation of large enterprises operating in the European Union in terms of the sustainable use of ICT tools and to reduce the dimension of variables describing the circular model of managing ICT solutions.

Due to the above objective, we conducted pilot studies, for which we obtained statistical data from the Statistical Office of The European Communities (Eurostat) database from the sections on ICT and environment by size class of enterprise, sustainable development indicators, and ICT usage in the enterprise by NACE Rev. 2 activity in enterprises employing 25 people or more for the year 2022.[2] We interpreted the results using the diagnostic-descriptive method with principal component analysis (PCA), the MOORA method, and the grouping of linearly ordered objects.

The article is divided into four parts. The first section presents the theoretical background along with a review of the literature on the circular economy, highlighting the importance of information and com-

[1] VUCA is an acronym for Volatility, Uncertainty, Complexity, Ambiguity. BANI is an evolution of the 1980s concept of VUCA and means functioning in a Brittle, Anxious, Non-linear, Incomprehensible environment.

[2] The European Union (EU) has released such statistics for the first time for 2022.

munication technologies in achieving sustainable development goals. Additionally, it addresses the need to transform the linear economy model into a circular one and to implement pro-ecological solutions in the processes of manufacturing, using, and disposing of IT equipment to minimize their negative impact on the environment. The second section outlines the research methodology, detailing the methods used: principal component analysis, multi-objective optimization based on ratio analysis, linear ordering, the Gini coefficient, and the Lorenz curve. The third section describes the data collection process, presents the results of the analysis, and verifies the research hypotheses. The final section analyses the empirical findings to date and discusses the limitations of the research along with its future directions.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The European Union's Assumptions for a Sustainable Circular Economy

The SD concept, popularized in the late 1980s by the United Nations (UN) Commission on Environment and Development, was created in connection with the need to counteract the degradation of the natural environment. In 2015, over 190 countries in the UN accepted the resolutions resulting from the '2030 Agenda' and thus decided to apply 17 Sustainable Development Goals (SDGs) in their national regulations, including 169 detailed tasks (Costa *et al.*, 2024).

Scholars consider SD as an integral approach to business aimed at strengthening competitive advantage and profitability through the sustainable creation of shared value and close cooperation with all stakeholders, as well as the integration of factors: E – environmental, S – social responsibility and G – corporate governance (ESG) in the decision-making process (Taticchi & Demartini, 2021). However, one of the first definitions indicates that it is development that meets current needs without depriving future generations of the possibility of meeting their needs. Thus, the essence of SD is to introduce such a process of change in which the exploitation of resources, directions of investment, the course of technological progress and institutional changes remain in harmony, maintaining the current and future possibility of satisfying human aspirations (Keeble, 1988).

The current inadequacy of the adopted SD development model results from the maintenance of a linear management model in line with the principle of 'take – produce – use – throw away,' which makes it impossible to reuse depleted resources. Thus, the availability of natural resources has significantly exceeded the prospects for their reconstruction. Conditions of this type indicate that the linear model of the economy is inappropriate, destabilizing, and takes on a character that does not engage in the SD idea. Therefore, changing the indicated circumstances is possible by using the CE model.

The CE concept recognises that the value of products, materials, and resources is maintained for as long as possible and that waste generation is minimized as an important contribution to the European Union's (EU) efforts to create a sustainable, low-emission, resource-efficient, and competitive economy (COM/2014/0398, 2014). To strengthen the circularity level, organizations should apply the 3R principle (reduce, reuse, recycle), at least in the area of waste handling. This approach concerns reducing (1R) or waste generation. It is considered the first stage in companies' efforts to implement the concept of sustainable development, which involves reducing the consumption of natural resources and energy. Another element of the 3R principle is reuse (2R), which involves extending the life cycle of products. It is based on the reuse of products, reducing the demand for new resources. The last component, recycling (3R), concerns the transformation of waste into secondary raw materials. As a result of this process, materials are transformed into new products that reduce the demand for natural resources and reduce the amount of waste. The above-mentioned 3R circular economy standards display close interdependence. The order in which they are implemented is also crucial. Therefore, products that are not subject to the reduction process should be reused so that they are recycled during the last stage. Implementation of such activities allows for the systematic use of secondary raw materials in production processes. Such a procedure contributes to the reduction of energy and natural resources use. In this way, it supports the implementation of the objectives of the circular economy by reducing the negative impact of companies on the environment (Appiah-Otoo *et al*., 2023). Based on this rule, the Canadian formula 4RV + ogeS was created, i.e., reduce, reuse, recycle, regenerate, valorize + zero greenhouse gas emissions. The next configuration

concerns the Swiss 5R, consisting of reducing, repairing, reusing, recycling, and reinventing. The above-mentioned principles contributed to the creation of the 9R competitiveness level pyramid, in which the following activities were distinguished: refuse, reduce, re-reuse, repair, refurbish, remanufacture, re-purpose, recycle, and recover (Cramer, 2023).

The EU's strategic plans record the transformation of the economy following the procedures into a closed loop. At the end of 2015, the EU adopted the directive Closing the Loop: An EU Action Plan for the Circular Economy, the so-called CEAP1, which concerned the plan of action undertaken in connection with implementing the principles of a closed loop in each product life cycle. At the same time, next to CEAP1, the European Commission disseminated a set of legislative proposals (the so-called Circular Economy Package – CEP), which concerned the reform of the previously legally binding directives on waste, storage, packaging waste, and end-of-life vehicles, used batteries, accumulators, electrical and electronic equipment (Directive 2012/19/EU, 2012). The fundamental changes resulting from the directive concern included the following CE components:

- formulating common EU recycling targets and preparing the reuse of municipal waste by 2025 – with the recovery of 60%, and by 2030 – 65%;
- defining a common EU target for recycling packaging waste produced from plastics (by 2025 – 55%; 2030 – 65%), wood (by 2025 – 60%; 2030 – 75%), ferrous metals (by 2025 – 75%; 2030 – 85%), aluminium (by 2025 – 75%; 2030 – 85%), glass (by 2025 – 75%; 2030 – 85%), paper and cardboard (by 2025 – 75%; 2030 – 85%);
- a ban on storing selectively collected waste;
- promoting financial and economic instruments that discourage the waste storage process;
- organising an early warning system enabling monitoring and control of compliance with the implementation of recycling activities and targets;
- providing financial resources as an incentive for producers who plan to produce ecological products and support recycling programmes.

Moreover, the developed program indicated the requirement to intensify the use of many existing methods of measuring tasks conducted within the CE. These include procedures such as material flow analysis (MFA), life cycle assessment (LCA), diagnosis of mechanisms in the field of green public procurement (GPP), eco-management and audits (EMAS), environmental technology system control (ETV), extended producer responsibility (EPR), best available techniques (BREF), and ecodesign (COM/2014/0398, 2014).

At the beginning of 2021, the EU adopted a new Circular Economy Action Plan for a Cleaner and More Competitive Europe (CEAP2), which is a continuation of CEAP1 and ESG. This program concerns an additional 35 actions influencing the process of transforming the economy into a circular one and defining a new level of the circularity indicator. According to the adopted directive, it should be doubled by 2030.

The program consists of five strategic directions of EU action, which refer to the scope of intervention. The first one sets out the procedures of sustainable product policy concerning their design, strengthening the position of consumers and public purchasers and closed circulation in production processes. The second direction refers to key product value chains and supporting selected sectors of the economy. The third part of the plan recommends reducing the amount of waste, drawing attention to the mandatory implementation of an effective policy in this area, which should support the prevention of waste generation. The fourth component of the program indicates the adaptation of the closed loop to the requirements of society, regions and cities. In turn, the final fifth element of the program includes cross-sectional activities carried out in the implementation of CE principles. Thus, the closed loop is presented from the perspective of a criterion influencing the achievement of climate neutrality. In this type of economic model, special attention is paid to profitability and support for its implementation through the development of research, innovation, and digital transformation. CEAP2 indicates the obligation to minimize the carbon and material footprint and the extension of the closed loop in the industrial sector to all its industries (COM/2020/102, 2020). Based on the above analysis of the literature on the subject, we put forward the following thesis:

T1: Large enterprises operating in the European Union are implementing selected principles that enhance the level of circularity, leading to a reduction in the negative impact of ICT equipment on the environment in the selection, operation, and disposal of such devices, resulting from the implementation of the sustainable development strategy.

ICT Technologies as a Key Component of the Circular Economy

Implementation of new ICT technologies in the management and development process of entities is a key condition for maintaining their competitive position. However, along with the expansive technological and industrial development, the economies of countries are constantly struggling with difficult tasks related to the devastation of nature, loss of biodiversity, anthropogenic climate changes and their negative consequences.

In connection with the threats indicated above, the EU has decided to draw attention to the interdependence between the implementation and use of ICT technologies and the protection of the natural environment. Consequently, the European Commission consistently analyses the connections between digitalization and the natural environment primarily from the perspective of sustainable development policy, the European Green Deal, the Digital Decade of Europe, the European Industrial Strategy, and the European Coalition for Green Digitalization.

Moreover, scholars consider ICT technologies tools that ensure the processing, collection, and transmission of information in electronic form (Arbeláez-Rendón *et al.*, 2023). They are based on seven main elements, consisting of software, computer hardware and peripherals (printers, scanners), cloud computing, transactions, ICT, data, and Internet access (Desruelle & Stančík, 2014). The rapid spread of ICT contributes to intensive energy consumption and excessive greenhouse gas emissions and, as a result, has a negative impact on the natural environment. Moreover, ICT equipment poses a serious environmental problem in the production and disposal phases. The indicated results are inconsistent with the SD goals adopted in the EU (Börjesson Rivera *et al*., 2014; Roussilhe *et al.*, 2023). Moreover, the popularization of information technology also contributes to the increase in the amount of electronic waste (Zahra, 2011; Laranja Ribeiro *et al.*, 2021).

The most important stage of implementing the SD and CE concepts resulting from cre for the environment is the implementation of the Green ICT/IT strategy, *i.e*., the use of ecological solutions in the area of information and communication technologies. Therefore, actions taken by large companies in this area should concern the design, production, planning, operation and recycling of computers, servers, subsystems, and devices such as monitors, printers, disks, communication, and network systems. In connection with the introduced directives, entities operating in the EU are obliged to implement the indicated stages considering an ecologically rational and efficient approach and limiting or completely reducing the negative impact on the natural environment (McNamee *et al.,* 2010).

Green IT/ITC concerns the sustainable use of resources, considering their increasing benefits for the environment and the economic system. Such circumstances are related to the need to reduce the negative impact of economic activity on the environment and in particular, to promote the SD strategy in all areas of the organization's functioning (Lautenschutz *et al.*, 2018; Awewomom *et al.*, 2024). For this reason, scholars consider such technologies an optional concept that allows for resolving environmental dilemmas in the field of resource-efficient production and environmental protection

The literature defines green information technology (IT)/ICT as an organization's ability to systematically adapt to the SD criteria of the environment (such as pollution prevention, equipment management, and use of clean technologies) in the design, production, acquisition, use and disposal of IT technology infrastructure, as well as the ability to adapt human and managerial elements of the IT infrastructure (Hernandez, 2018).

Scholars consider green IT/ICT to be the science and principle of designing, manufacturing, and disposing of computers, servers, and related components (*e.g*., monitors, printers, external drives, external memory media, software, network systems, communication systems, and data transmission) in an efficient and reliable manner with minimal impact on the environment. Taking the above actions enables an organization to achieve economic profitability and improve the efficiency of operating IT systems, taking

into account the social, ethical, and environmental dimensions of SD (Unhelkar, 2011). Therefore, the Green IT/ICT concept considers the dimensions and levels of environmental sustainability, the energy efficiency system and the total cost of ownership of the technology, which includes disposal and recycling (Murugesan & Gangadharan, 2012). Green IT/ICT technologies should meet the following criteria: a) minimize environmental degradation, b) reduce greenhouse gas emissions to zero, contributing to a safe environment for the health of society and other forms of life, c) limit the consumption of natural resources and electricity, d) increase the use of renewable energy sources (Fawole *et al.*, 2023).

The implementation of Green IT/ICT is related to the implementation of two basic and mutually subordinate strategic goals. The first one supports companies in activities that reduce the direct contribution of IT technologies to carbon footprint emissions. The second one enables meeting the challenges related to overall greenhouse gas emissions by using green technologies that reduce the environmental footprint of the company (Butler & Hackney, 2021).

The fundamental goal of the Green IT/ICT strategy is to reduce energy consumption and operating costs while controlling the ever-increasing requirements related to efficiency and resource multiplication. We should consider the effect of IT/ICT devices on the environment from a two-category perspective. The first one concerns the first-order effects, which refer to the negative impact of the production, use, and disposal of IT/ICT equipment (Hilty & Aebischer, 2014; Kumar & Daman, 2023). Second-order consequences refer to the desired impact of information systems (IS) on improving the environmental sustainability of enterprises and society following the Green IS concept (Anthony Jr, 2019; Theis & Schreiber, 2020).

Moreover, apart from minimizing energy consumption, the strategic goal of Green IT is to reduce greenhouse gas emissions generated by computer systems and data centre infrastructure. The implementation of the above-mentioned goals is supported by the following strategic actions, which consist in reducing PCs' energy consumption, enabling energy management functions, turning off unused systems, using screen savers, using thin client computers, using ecological data centres, saving energy, eco-friendly design and virtualization (Murugesan & Gangadharan, 2012; Ojo & Fauzi, 2020).

The literature on the subject identifies four key principles that enable the use of environmentally friendly IT/ICT technologies, which are: a) the use of natural materials recovered in the process of sustainable consumption, b) rational management of IT/ICT devices at the end of their life cycle, c) reduction in greenhouse gas emissions and pollutants as a result of improved production processes, d) continuous improvement of environmentally friendly standards to protect the environment and secure human health (Anthony *et al.*, 2020). The above assumptions emphasize the versatility of using the green IT/ICT strategy as a program aimed at reducing carbon footprint emissions *(*Asadi *et al.*, 2017; Queirós *et al.*, 2020). Nowadays, the SD and CE concept in the field of green technologies is complemented by the following goals: a) energy efficiency resulting from storing and virtualizing data in the cloud, optimization, cooling and intelligent management of energy used by the computer, b) ecological office environment: intelligent and natural room lighting systems, paperless information processing, c) ecological transport, d) ecological industry, e) waste management: reuse, reduction, recycling of resources (Khadivar *et al.*, 2024).

The implementation of the above-mentioned strategic actions and programs allows companies to gain an advantage resulting from the use of energy-saving and environmentally friendly solutions. Strategies related to the improvement of processes aim at reducing energy consumption, proper processing and disposal of e-waste, enabling the extraction of raw materials from them, and the application of a recycling process that provides entities with significant savings as well as the implementation of CE principles together with SDG. Based on an analysis of the literature on the subject, the thesis is that:

T2: Despite uniform legal regulations of the European Union, large enterprises still differ in the level of use and circularity of ICT equipment and in their adaptation to sustainable development criteria in accordance with the principles of selection, repair, recycling, reuse, and management of green ICT resources, which affect the effectiveness of closing material loops in the circular economy model.

RESEARCH METHODOLOGY

Principal Component Analysis

Principal component analysis (PCA) is based on the correlation or covariance matrix resulting from the initial set. This method allows for the selection of primary variables that have a significant impact on the value of individual principal components (PC), *i.e.*, those that shape a homogeneous group. In such a case, PC is a representative of this group. On the other hand, the remaining components are orthogonal, and their number is smaller or equal to the number of primary variables (Tsoulfidis & Athanasiadis, 2022). Based on the applied PCA, the new model is created describing the structure of dependencies between the studied variables. Thus, the mathematical PCA model is shaped using the following system of linear equations (Drees & Sabourin, 2021):

$$\begin{gathered} X_1 = a_{11}Z_1 + a_{12}Z_2 + \cdots + a_{1p}Z_p \\ X_2 = a_{21}Z_1 + a_{22}Z_2 + \cdots + a_{2p}Z_p \\ \vdots \\ \boldsymbol{X_p = a_{p1}Z_1 + a_{p2}Z_2 + \cdots + a_{pp}Z_p} \end{gathered} \quad (1)$$

in which:

X_p - *p*-th variable (*p=1,2,…,n*);

$Z_1 \ldots Z_n$ - main components;

$a_{p1} \ldots a_{pp}$ - principal component coefficients.

In the next stage of the analysis, we selected factor loadings to consider an appropriately large share in explaining the total variability of the output data. As a rule, we selected an appropriate number of dimensions (D), the variance of which cannot be less than 75% of the total variability (Morrison, 2004). We extracted the number of PCs using the scree criterion and Kaiser (Boudt *et al.*, 2022), which is based on including only dimensions with eigenvalues greater than 1 in further analysis. In connection with the study, we rotated the collected data according to the normalized varimax (maximum of the variance) method, which allowed the maximum differentiation of loadings in the dimension area.

The key assumption of the PCA method is the appropriate comparison of results and loadings of vectors corresponding to the maximum eigenvalues, which include the most important information regarding the analysed problem. Therefore, using PCA, we created a new set of orthogonally located descriptors called PC. They represent the majority of information included in the independent variables according to the minimizing values of variance (Hilbert & Bühner, 2020).

In connection with the identification of the activities of large enterprises related to the implementation of the circular economy when selecting, operating, and discontinuing the use of ICT devices, in the first stage of the research, we selected 15 diagnostic variables from the Eurostat database for 2022 from the ICT and environment section by enterprises' size class:

X1 – Enterprises applying some measures affecting the amount of paper used for printing and copying;

X2 – Enterprises applying no measures affecting the amount of paper used for printing and copying;

X3 – Enterprises applying some measures affecting the energy consumption of the ICT equipment;

X4 – Enterprises applying no measures affecting the energy consumption of the ICT equipment;

X5 – Enterprises applying some measures affecting the paper or energy consumption of the ICT equipment;

X6 – Enterprises with very high digital intensity index, which apply some measures affecting the paper or energy consumption of the ICT equipment;

X7 – The enterprises considered the environmental impact of ICT services, or ICT equipment before selecting them;

X8 – Enterprises with a very high digital intensity index, which considered the environmental impact of ICT services, or ICT equipment before selecting them;

X9 – The enterprises considered the environmental impact of ICT services, or ICT equipment before selecting them and applying some measures, affecting the paper or energy consumption of the ICT equipment;

X10 – Enterprises with a very high digital intensity index, which considered the environmental impact of ICT services, or ICT equipment before selecting them, and applying some measures, affecting the paper or energy consumption of the ICT equipment;

X11 – When the ICT equipment of the enterprise is no longer used, it is disposed of in electronic waste collection/recycling;

X12 – When the ICT equipment of the enterprise is no longer used, it is kept in the enterprise;

X13 – When the ICT equipment of the enterprise is no longer used, it is not kept in the enterprise;

X14 – When the ICT equipment of the enterprise is no longer used, it is sold, returned to a leasing enterprise, or donated;

X15 – When the enterprise's ICT equipment is no longer used, it is not sold, returned to a leasing enterprise, or donated.

Multi-attribute Optimization Method and Linear Ordering by Standard Deviations

The literature considers the multi-objective optimization method based on ratio analysis (MOORA) to be an objective, multi-criteria method used to solve problems related to the decision-making process (Karande & Chakraborty, 2012). It is based on ratio analysis and the concept of a reference point or proportion system. It also serves to solve complex problems that have several divergent attributes that are subject to constraints (Chakraborty *et al.*, 2023). MOORA effectively shows excellent correlation of priority order with the reference solution, which is not affected by additional attributes (Behzadian *et al.*, 2010; Singh *et al.*, 2024) and unspecified criteria weights (Sutarno *et al.*, 2019). Therefore, this method can simultaneously analyse multiple quantitative and qualitative choice attributes in the decision-making process (Pérez-Domínguez *et al.*, 2018).

However, in the situation of considering a decision problem, the criteria and their results must be measurable to enable measurement for all supposed alternatives. Among the opposing criteria, certain ones are considered favourable (reaching the maximum value), and others are considered unfavourable (for which the minimum values are preferred in each case). In the MOORA ratio method, both types of criteria are considered with the aim of organizing and isolating one or more alternatives from the set of available possibilities (Arshad *et al.*, 2024).

We initiated the research process using the discussed method with a decision matrix (*x*) (step 1):

$$\boldsymbol{x} = \begin{bmatrix} \boldsymbol{x_{11}}, \boldsymbol{x_{12}} & . & \boldsymbol{x_{1n}} \\ \boldsymbol{x_{21}}, \boldsymbol{x_{22}} & . & \boldsymbol{x_{2n}} \\ \boldsymbol{x_{m1}}, \boldsymbol{x_{m2}} & . & \boldsymbol{x_{mn}} \end{bmatrix} \tag{2}$$

in which:

x_{ij} - output quality characteristic of different attributes of *m* alternative values in criterion *n*, i=1,2,…, *n*;

n - number of attributes *j = 1,2,…, m*;

m - number of alternatives.

Then, we conducted the decision matrix data normalization, during which we transformed the values of each criterion from different alternatives into values that allow direct comparison (step 2) according to the formula:

$$\boldsymbol{x_{ij}^{*}} = \frac{\boldsymbol{x_{ij}}}{\sqrt{\sum_{\boldsymbol{i=1}}^{\boldsymbol{m}} \boldsymbol{x_{ij}^{2}}}} \tag{3}$$

in which:

x_{ij} - response of alternative *j* to attribute *i; j=1,2,…,m*;

m - number of alternatives; *i=1,2,…,n*;

n - number of attributes;

x_{ij}^{*} - dimensionless number in the interval [0,1] representing the normalized response of alternative *j* to criterion *i*.

In the case of normalized multi-objective optimization, we summed the results for favourable attributes (maximization) and limited when unfavourable attributes occur (minimization). Then the optimization problem proceeds according to the formula (step 3):

$$\boldsymbol{y_i = \sum_{j=1}^{g} x_{ij}^{N} - \sum_{j=g+1}^{n-g} x_{ij}^{N}} \quad (4)$$

in which:

g - number of attributes that should be maximized;

$(n-g)$ - number of attributes that should be minimized;

y_i - normalized value of the alternative with respect to all attributes.

Next, we multiplied the normalized criteria values by the appropriate criteria weight coefficients to obtain the following optimization relationship:

$$\boldsymbol{y_i = \sum_{j=1}^{g} w_j * x_{ij}^{N} - \sum_{j=g+1}^{n-g} w_j * x_{ij}^{N}} \quad (5)$$

in which:

w_j - the weight of the *j*-th attribute, which we can attribute using the analytic hierarchy process (AHP) method or the selected entropy method.

For this research, we used the Shannon entropy method.

According to the weighted values of the criteria, y_i can have a positive or negative scale in relation to the maximum (favourable attribute) and minimum (unfavourable attribute) number in the decision matrix. We indicated the preference based on the ranking of alternatives according to the obtained value y_i. The best alternative had the highest value of y_i, while the marginal alternative had the lowest level y_i (step 4). In the MOORA method, it is recommended to prepare a systematic ranking of y_i values for each alternative in order to make final decisions, enabling decision-makers to determine the optimal alternative (Brauers & Zavadskas, 2009).

Recently, the MOORA method has gained popularity in solving problems related to engineering designs, real estate performance assessment, robot selection, personnel selection, quality control, production scheduling, medical waste management, health care management, site selection, enterprise selection, and determining the recipients of intelligent applications (Thakkar, 2021; Ngemba *et al.*, 2021; Akmaludin *et al.*, 2021; Rizk-Allah *et al.*, 2020; Akkaya *et al.*, 2015; Arabsheybani *et al.*, 2018; Dinçer *et al.*, 2019).

In turn, the standard deviation method allows for the systematization of variants based on the study of the deviations of the aggregated variable value (in this study, the value of the y_i, indicator, which was obtained in stage 3 of the MOORA method) from the average value of this variable (Panek & Zwierzchowski, 2013). Therefore, it is possible to divide objects, considering the level of the studied phenomenon, and classify them into four typological groups. The basis for the process of generating classes of linearly ordered objects are the ranges of the y_i u indicator values formed using the arithmetic mean ($\bar{s}$) and the standard deviation *S*(*s*) (Rani *et al.*, 2023). The created set of objects is arranged into four groups containing objects with values of the synthetic variable from the following disjoint ranges (Şahin, 2021): group I: $y_i \geq \bar{s} + S(s)$; group II: $\bar{s} + S(s) > y_i \geq \bar{s}$; group III: $\bar{s} > y_i \geq \bar{s} - S(s)$; group IV: $y_i < \bar{s} - S(s)$.

Categories classified in group I displayed a very high level of the phenomenon being studied. Group II, on the other hand, included objects with a high level of this phenomenon. Group III, however, included variants with an average intensity of the analysed event. The final group IV consisted of objects representing a low level of the diagnosed phenomenon.

To diagnose the degree of diversity of large enterprises from the 27 EU countries from the perspective of the sustainable use of ICT tools, we considered a total of 18 variables, including the 15 indicated in the previous point used for the PCA analysis and three additional diagnostic variables from the Eurostat database for 2022 from the ICT and environment by size class of enterprise, sustainable development indicators, and ICT usage in enterprise sections.

In the process of creating the ranking using the MOORA method, we identified the variables that should be maximized and minimized. Table 1 presents them.

Table 1. Attributes subject to maximization and minimization

Variable name	Variable description	Optimization type
X1	Enterprises applying some measures affecting the amount of paper used for printing and copying	Maximization
X2	Enterprises applying no measures affecting the amount of paper used for printing and copying	Minimization
X3	Enterprises applying some measures affecting the energy consumption of the ICT equipment	Maximization
X4	Enterprises applying no measures affecting the energy consumption of the ICT equipment	Minimization
X5	Enterprises applying some measures affecting the paper or energy consumption of the ICT equipment	Maximization
X6	Enterprises with very high digital intensity index, which apply some measure affecting the paper or energy consumption of the ICT equipment	Maximization
X7	The enterprises considered the environmental impact of ICT services or ICT equipment before selecting them	Maximization
X8	Enterprises with very high digital intensity index, which considered the environmental impact of ICT services or ICT equipment before selecting them	Maximization
X9	The enterprises considered the environmental impact of ICT services, or ICT equipment, before selecting them and applying some measures affecting the paper or energy consumption of the ICT equipment	Maximization
X10	Enterprises with very high digital intensity index, which considered the environmental impact of ICT services or ICT equipment before selecting them, and apply some measures, affecting the paper or energy consumption of the ICT equipment	Maximization
X11	When the ICT equipment of the enterprise is no longer used, it is disposed of in electronic waste collection/recycling	Maximization
X12	When the ICT equipment of the enterprise is no longer used, it is kept in the enterprise	Minimization
X13	When the ICT equipment of the enterprise is no longer used, it is not kept in the enterprise	Minimization
X14	When the ICT equipment of the enterprise is no longer used, it is sold, returned to a leasing enterprise, or donated	Maximization
X15	When the ICT equipment of the enterprise is no longer used, it is not sold, returned to a leasing enterprise, or donated	Minimization
X16	Reducing electricity consumption by ICT equipment	Minimization
X17	Enterprises with very high digital intensity index	Maximization
X18	Circular material use rate	Maximization

Source: own study.

Gini coefficient and Lorenz Curve

The Gini concentration coefficient is a solution used to measure the unevenness of the distribution of a random variable. The Lorenz concentration curve is its graphical representation, based on which it is estimated. The Gini index reflects the proportion of the area located between the concentration curve and the line of uniform distribution to the area of the triangle placed under the line of uniform division (Göktaş & Akkuş, 2021). The concentration space is the area between the diagonal of a unit square and the Lorenz curve, with the probable maximum coinciding with the area below the diagonal (egalitarian line). The maximum area of the concentration surface is considered to be the area of a right-angled triangle, which was defined by the line $y = x$, as well as the segments with edges (0.0); (1.0) and (1.0); (1.1) (Blesch *et al.*, 2022). To determine the Gini coefficient, we may use the following formula (Kristensen, 2022):

$$\boldsymbol{G(y)} = \frac{\sum_{i=1}^{n}(\boldsymbol{2i - n - 1}) * \boldsymbol{y_i}}{\boldsymbol{n^2} * \boldsymbol{\bar{y}}} \tag{6}$$

in which:

n - number of observations;
y_i - value of the *i* – th observation;
$\bar{y}$ - average value of all observations, *i.e.*, $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$.

In the above formula, the y_i values should be arranged in ascending order, and i symbolizes the unit number in the ascending sequence. The Gini coefficient occurs in the interval [0;1] (Marchetti & Tzavidis, 2021). It is created based on the Lorenz curve, which determines the degree of concentration of a one-dimensional distribution of a random variable. It is created by connecting points whose coordinates occur as cumulative relative frequencies of variables arranged according to increasing share and integrated parts of the studied feature of a specific entity and all its preceding units. The curve is located in a unit square with a side of 100 (100% = 1) units of measurement of the designated scale, within which points with coordinates defined by cumulative indicators are placed. Its boundaries are formed by the lower left and upper right vertices of the square. By connecting the obtained points with straight line segments, a concentration polygon is obtained. In turn, if they are connected with a curved line, a concentration curve (Lorenz) is generated (Sitthiyot & Holasut, 2021).

In the case of ranked observations $\mathrm{y_i}$, which have non-negative values $0 \le \mathrm{y_i} \le \mathrm{y_2} \le \cdots \le \mathrm{y_n}$, $\sum_{\mathrm{i=1}}^{\mathrm{n}} \mathrm{y_i} > 0$, the Lorenz curve takes the form of a broken line whose vertices $(\mathrm{x_h}, \mathrm{z_h})$, for $\mathrm{h} = 0,1, \ldots, \mathrm{n}$, with the following coordinates (Chang *et al.*, 2018):

$$\boldsymbol{x_0 = z_0 = 0},\ \boldsymbol{x_h = \frac{h}{n}},\ \boldsymbol{z_h = \frac{\sum_{i=1}^{h} y_i}{\sum_{i=1}^{n} y_i}} \tag{7}$$

in which:
n - number of observations;
y - the value of the i-th observation;
y_n - level of the phenomenon in a certain period.

The concentration curve is a straight line created as a result of combining points with the following coordinates (Schneider, 2021):

$$\left(\boldsymbol{N}, \sum_{\boldsymbol{i=1}}^{\boldsymbol{N}} \boldsymbol{u_i}\right) \tag{8}$$

in which:
N - number of a given entity in the ordered set of entities according to the decreasing share in the total value of the feature, *N* – takes values from *1* to *n*;
u_i - an indicator of the share of a given feature.

The slope coefficient of a straight line

A linear function is a relationship defined as $f: R \to R$. On the other hand, we can determine a straight line in the coordinate system that is not parallel to the Y-axis by a functional formula determining the so-called directional equation (Glen & Zazkis, 2021):

$$\boldsymbol{y = ax + b} \tag{1}$$

in which:
$a, b \in R, a$ - slope;
b - free term of the linear function.

The slope *a* in the above linear function formula represents the increase in the function value as a result of increasing the argument by 1. And the intercept *b* determines the point where the graph of the function intersects the Y-axis (Wells, 2016).

Therefore, the slope coefficient determines the degree of the straight line slope, which is equal to the tangent of the angle of the tangent to the curve that the given straight line draws with the positive direction of the X-axis. To interpret the level of the slope of the tangent to the graph, one indicates the increase in the value plotted on the X-axis and the corresponding increase in the value on the Y axis (Stoer & Bulirsch, 2002). By estimating the dependence of the indicated increments, we obtained the value of the slope of the tangent, *i.e.*, $\Delta y/\Delta x$. In turn, its graph is a straight line intersecting the Y-axis at the point (0,b) and inclined to the positive semi-axis X at an angle α consistent with the relationship $tg\alpha = \mathrm{a}$ (Bewick *et al.*, 2003).

RESULTS AND DISCUSSION

Circular Activities of Large Enterprises in the Area of ICT Solution Management

In the first stage, we identified the actions of large enterprises undertaken in connection with implementing the concept of closed-loop ICT equipment and its selection, taking into account the impact on the environment following the SD strategy. To present the procedure related to the selection, recycling, and disposal of devices used for the digitalization of the studied entities, we used the PCA method.

The study made it possible to distinguish identical dimensions (course of action) that contribute to the correlation between the analysed variables (CE assumptions regarding the management of ICT resources). We indicated the degree of dependence between individual attributes by the correlation matrix (see Table 2). The absolute value of the correlation coefficient informs us of the strength of the dependence between the analysed variables. We obtained strong positive and negative correlations.

The symmetry of the matrix allowed us to omit information above the main diagonal to increase clarity. The values of the correlation coefficients obtained for the observed pairs of variables ranged from -0.9999 to 0.9847 and thus indicated a strong relationship between the variables. We initiated the process of extracting the dimensions of the factors by analyzing the significance of the correlation matrix. Therefore, we applied Bartlett's sphericity test and assessed the adequacy of the input variables selection for the PCA analysis using the Kaiser-Mayer-Olkin coefficient (KMO). The value of the KMO coefficient at the Overall MSA level was 0.707, with the simultaneous significance of Bartlett's test of sphericity $\chi^2 = 431.608$, df = 105.000, p <0.001 (see Table 3).

The obtained KMO measure (0.707) exceeded the acceptable threshold of 0.5 and thus confirmed the validity of using PCA analysis. On the other hand, Bartlett's test of sphericity enabled us to verify the null hypothesis (H0), assuming that the correlation matrix between variables used in the analysis was unique. Based on the obtained p-value (<0.001), we rejected H0 in favour of the alternative hypothesis (H1). This result indicates that the correlation matrix was not unique, and there were significant correlations between the analysed variables, indicating the occurrence of unobservable dimensions. Thus, the test values justified the use of PCA analysis.

The PCA data graphic projection technique made it possible to isolate the connections and disharmonies that occurred between the studied behaviours of large enterprises related to the transformation focused on SD through the implementation of CE principles regarding the use of ICT equipment in the combination of the first two PCs (see Figure 1).

Based on the obtained data, we prepared a PCA projection, in which orthogonal variables explained a total of 71.37% of the total variance, *i.e.*, the total multidimensional variability of the application of procedures for eliminating the potential impact of ICT technologies on the natural environment was transformed. The applied analysis showed that the type of activities undertaken by the surveyed organizations in the field of CE differentiated by features related to the first seven components D1-46.50%, D2-27.87%, D3-11.69%, D4-6.34%, D5-4.65%, D6-3.66%, and D7-1.99%. Together, the above-mentioned components explained 99.70% of the total variance, *i.e.*, the total multidimensional variability of the implemented standards. Therefore, the conducted study revealed that the adaptation of material loops to minimize the consumption of raw materials in large enterprises was characterized by differentiation due to the applied CE procedures.

The projection of the standardized D1 and D2 coefficients, found in linear combinations with the variables responsible for the type of procedure resulting from the management of ICT resources onto a circle with a unit radius and centre at the origin of the coordinate system, presents groups of correlated CE procedures used by entities (see Figure 1).

Table 2. Matrix of coefficients of correlation between variables

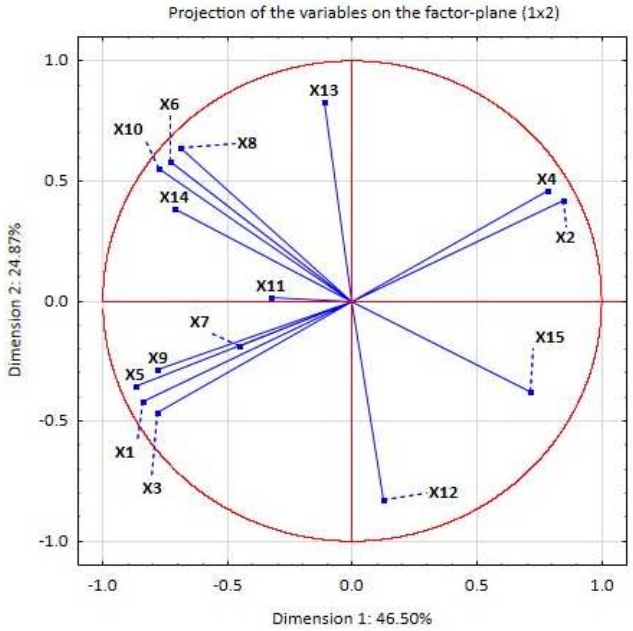
Variables	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	1.0000														
X2	-0.9999	1.0000													
X3	0.7984	-0.7996	1.0000												
X4	-0.7969	0.7983	-0.9998	1.0000											
X5	0.9814	-0.9815	0.8002	-0.7989	1.0000										
X6	0.3748	-0.3747	0.3253	-0.3260	0.4422	1.0000									
X7	0.3344	-0.3339	0.4041	-0.4019	0.3045	0.0267	1.0000								
X8	0.2608	-0.2597	0.2358	-0.2354	0.3138	0.9199	0.3141	1.0000							
X9	0.7385	-0.7383	0.6808	-0.6787	0.7284	0.2662	0.8639	0.4064	1.0000						
X10	0.3845	-0.3837	0.3626	-0.3622	0.4367	0.9472	0.3057	0.9847	0.4602	1.0000					
X11	0.2534	-0.2538	0.1138	-0.1157	0.2684	0.3551	-0.1167	0.2635	0.0601	0.2763	1.0000				
X12	0.1582	-0.1580	0.2168	-0.2174	0.1152	-0.4711	-0.0240	-0.5434	0.0269	-0.4913	0.2084	1.0000			
X13	-0.1654	0.1655	-0.2260	0.2275	-0.1237	0.4633	0.0260	0.5382	-0.0293	0.4851	-0.2133	-0.9986	1.0000		
X14	0.3990	-0.4010	0.3194	-0.3233	0.4537	0.7281	0.0924	0.6453	0.3428	0.6823	0.3454	-0.2242	0.2096	1.0000	
X15	-0.4005	0.4028	-0.3248	0.3295	-0.4555	-0.7251	-0.0897	-0.6410	-0.3410	-0.6786	-0.3468	0.2182	-0.2015	-0.9991	1.0000

Source: own study.

Table 3. KMO measure and Bartlett's test of sphericity

KMO measure of sampling adequacy		0.707
Bartlett's test of sphericity	Approximate chi-square	431.608
	degrees of freedom	105.000
	p-value significance	< 0.001

Source: own study.



Variable	Dimension 1 of energy and paper usage of ICT equipment	Dimension 2 of unused ICT equipment
X1	-0.842820	-0.417227
X2	0.843337	0.417397
X3	-0.780474	-0.462084
X4	0.780499	0.460969
X5	-0.869534	-0.355662
X6	-0.732577	0.582495
X7	-0.452359	-0.187265
X8	-0.687906	0.639593
X9	-0.780416	-0.285914
X10	-0.776516	0.553312
X11	-0.323639	0.012419
X12	0.125051	-0.828178
X13	-0.114486	0.826869
X14	-0.713675	0.383368
X15	0.713874	-0.376790

Figure 1. Distribution of the main component loads in large enterprises implementing the principles of the circular economy for ICT equipment and secondary raw materials

Source: own elaboration in the Statistica package.

According to the determined loading vectors of the principal components, the activities undertaken by the surveyed companies with a very high digital intensity index were also characterized by a strong positive correlation. Their struggles led to the application of procedures affecting the consumption of paper or energy by ICT equipment (X6). They also considered the impact of ICT services or equipment on the environment before choosing them, and therefore, the entities introduced selected solutions regarding the consumption of paper or energy by ICT equipment (X10). In turn, D1 was characterized by a strong positive correlation, which concerns the procedures for unused ICT equipment. Therefore, the procedures of large enterprises focused on the disposal of such equipment as part of the collection or recycling of electronic waste (X11). Moreover, enterprises introduced solutions aimed at reducing the consumption of paper or electricity by ICT equipment (X5) and, before choosing ICT services and equipment, they consider their impact on the environment (X7).

The research also allowed us to distinguish activities related to reducing the adverse impact of ICT on the environment, which were distinguished by a strong negative correlation. This group included companies that store ICT equipment when it is no longer used (X12) or do not store used equipment (X13); unused devices are not sold, donated to charity, or returned to the lessor (X15), in companies with a very high digital intensity index, which take into account the impact of ICT services and equipment on the environment before choosing them (X8); large entities do not apply any procedures in the scope of activities aimed at reducing the consumption of paper for printing and copying (X2), but use solutions preventing excessive consumption of paper or energy by the used ICT equipment (X5); entities that do not initiate any activities in connection with minimizing the use of energy by ICT devices (X4) or use procedures that affect the amount of paper used for printing and copying (X1).

Furthermore, the applied PCA enabled the identification of actions taken by large enterprises as part of the elimination of the unfavourable impact of ICT technologies on the environment, which do not have correlations. These included entities that did not store unused devices of this type (X13) and those that considered the impact of ICT services or equipment on the environment, paper or energy consumption (X9) before choosing and using them; enterprises with a very high digital intensity index considered their impact on the natural environment before choosing information and communication services and technologies (X8) and used procedures that influenced the energy consumption of ICT equipment (X3); unused ICT devices were stored in enterprises (X12) that did not implement any procedures related to the use of the amount of paper for printing and copying (X2).

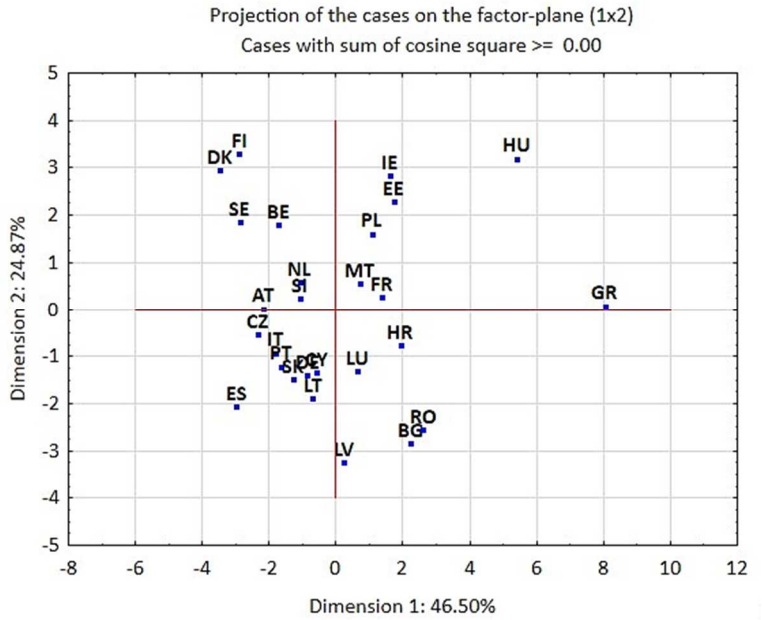


Figure 2. The degree of saturation in the implementation of the intentions to close the loop of ICT devices in large entities

Where: AT – Austria, BE – Belgium, BG – Bulgaria, HR – Croatia, CY – Cyprus, CZ – Czechia, DK – Denmark, EE – Estonia, FI – Finland, FR – France, DE – Germany, GR – Greece, HU – Hungary, IE – Ireland, IT – Italy, LV – Latvia, LT – Lithuania, LU –Luxembourg, MT – Malta, NL – Netherlands, PL – Poland, PT – Portugal, RO – Romania, SK – Slovakia, SI – Slovenia, ES – Spain, SE – Sweden.
Source: own elaboration in the Statistica package.

The final stage of the research, which was conducted using the PCA method, made it possible to obtain the result of projecting the location of enterprises in individual EU countries onto the dimensions of the planes (see Figure 2). It aimed to classify entities from the 27 EU countries based on identical actions taken to achieve circularity in the process of managing ICT equipment. The scatterplot showed four coherent groupings of countries that implemented CE principles regarding the methods of selecting, operating, and managing ICT equipment. The relatively homogeneous first group of countries, distinguished based on D1, consisted of CZ, IT, PT, SK, ES, CY, LT, and ES. The above-mentioned countries were characterized by the smallest negative factor loading values by being farthest to the left from dimension 1. This component informs about the methods of managing ICT equipment following CE principles. They consist of limiting the amount of waste and reducing pollution by closing the loop through the multiple uses of materials and recycling to extend their use by large enterprises. The second group of countries is formed by FI, DK, SE, BE, NL, SI, and AT, distinguished by positive factor loadings. The third group is formed by the countries located on the right in the graph closest to dimension 2 (D2), *i.e.*, LU, HR, RO, BG, and LV. The fourth cluster consisted of the countries IE, EE, PL, MT, and FR. Moreover, when analysing the distribution of points on the map, we should note that there are countries that differ from others in terms of the analysed variables. The first component has a fundamental impact on their differentiation. Thus, among the EU countries that differ from the studied group, we should distinguish two countries, namely GR and HU.

The conducted research shows that large enterprises operating in the 27 EU countries fragmentarily narrow the material loop resulting from the adaptation of ICT resources according to the 3xR hierarchy (reduce, reuse, recycle). It involves actions following the developed CE procedures aimed at rational management of raw materials and waste in the process of using ICT equipment and thus limiting its adverse impact on the natural environment. The surveyed enterprises use procedures X5, X6, X7, X8, and X10 as part of the first reduce principle. The subsequent standards of conduct result from the application of the X11 approach in the scope of the third recycle principle. However, the second reuse criterion is not currently included in the implemented CE concepts of large enterprises located in the EU.

On should consider the results of the PCA analysis should be consistent with the research conducted so far, which indicates differences in the implementation of CE principles depending on the region in which the enterprises operate (Geissdoerfer *et al.*, 2017; McMahon *et al.*, 2024). However, companies with a lower level of digitalization usually ignore the principle of reusing ICT equipment (Upadhyay *et al.*, 2021). Moreover, previous research results highlight the use of different CE models in companies, mainly depending on location and region, with highly specialized procedures and recycling strategies. They mostly concern countries with higher digital intensity FI, SE, and NL (Korhonen *et al.*, 2018). Thus, the conducted research confirms that the analysed entities implement the principles of the circular economy at the basic level of 3R, in a fragmented manner. They mainly focus on reduction (1R) and recycling (3R), while the reuse of equipment remains at the initial implementation stage.

In connection with the conducted research, it is necessary to verify the thesis that large enterprises implement selected principles, strengthening their level of circularity and leading to a reduction in the negative impact of ICT equipment on the environment in the scope of selection, operation, and disposal of such devices, resulting from the implementation of the SD strategy.

Sustainable Use of ICT Equipment in EU Countries

The circular economy uses a production and consumption model whose main goal is sustainable development resulting from the maximum extension of the life cycle of products. It results from the process of sharing, borrowing, repairing, certain use, reselling, refurbishing, and recycling previously used materials and products. Consequently, the essence of using this type of model of conduct is the possibility of achieving a positive impact on the natural environment. During the next stage of the research process, we presented the level of differentiation of large enterprises operating in the EU in terms of sustainable use of ICT tools using the MOORA method, which enabled the generation of a non-subjective ranking (see Table 4).

The ranking of large enterprises and grouping of objects using the standard deviation method indicated the differentiation of the level of sustainability and resource efficiency in the circulation of ICT devices, affecting their market competitiveness. The range for the analysed data between the maximum value for DE (20.647) and the situation of GR (-0.019) equalled 20.666.

The dominant position in the ranking was occupied by entities from DE (1st place), FR (2nd place), and ES (3rd place), which were characterized by significant values of diagnostic features. Large enterprises located in these countries are characterized by the highest degree of closed circulation in the management of ICT equipment. Therefore, when devices of this type are not used, they undertake activities consisting of their processing in the scope of selective collection or recycling of electronic waste (X11, DE – 92.1%; FR – 85.4%; ES – 92.1%). Moreover, they also reduce the consumption of energy (X5, DE – 84.3%, FR – 80.8%; ES – 91.5%) and paper for printing and copying (X1, DE – 80.3%; FR – 77.9%; ES – 90.5%) by ICT equipment. They also pay attention to the impact of ICT services and equipment on the environment before choosing them (X7, DE – 65.4%; FR – 66.6%; ES – 83.6%) and applying measures to reduce the consumption of paper and energy by this type of equipment (X9, DE – 61.0%; FR – 60%; ES – 81.3%; X16, DE – 44.7%; FR – 67.2%; ES – 52.8%). However, if such devices are not used, they are disposed of through sale, donation, or transfer to a leasing company (X14, DE – 60.2%; FR – 38.2%; ES – 53.9%).

Table 4. Circularity ranking of ICT tools of large enterprises

EU country	Y_i	MOORA Ranking	Typological Class
BE	3.09112	8	II
BG	0.87673	15	III
CZ	3.88717	7	II
DK	1.34806	14	III
DE	20.64743	1	I
EE	0.51175	19	III
IE	0.80918	16	III
GR	-0.01978	27	IV
ES	8.62807	3	I
FR	9.01042	2	I
HR	0.31916	22	III
IT	8.52856	4	I
CY	0.06388	26	III
LV	0.27424	23	III
LT	0.51665	18	III
LU	0.23444	25	III
HU	0.79527	17	III
MT	0.46766	20	III
NL	5.33632	6	II
AT	2.82469	9	III
PL	5.74425	5	II
PT	1.74168	11	III
RO	1.71924	12	III
SI	0.23732	24	III
SK	1.35658	13	III
FI	0.35797	21	III
SE	2.68905	10	III

Source: own study in MATLAB&Simulink.

The last places in the ranking belonged to large enterprises located in GR (27th place), CY (26th place), and LU (25th place). This type of entity was characterized by the lowest level of circular management of their ICT devices in terms of unused computer equipment that was not sold, returned to the leasing entity, or transferred free of charge (X15, GR – 81.9%; CY – 51.4%; LU – 52.2%) but stored in the enterprise (X12, GR – 61%; CY – 63.9%; LU – 59.2%). Furthermore, the surveyed entities did not take any actions to reduce the consumption of energy (X4, GR – 56%; CY – 39.5%; LU – 42.6%) and paper used for printing and copying documents (X2, GR – 52.3%; CY – 18.5%; LU – 20.7%) by such devices. They applied only some measures influencing the paper and energy consumption of ICT equipment to a small extent (X6, GR – 6.8%; CY – 20.5%; LU – 16.1%). Moreover, large entities with a very high digital intensity index did not consider the impact of ICT equipment on the natural environment before deciding to purchase it (X8, GR – 4.4%; CY – 23.9%; LU – 13.4%).

According to the determined measures (Yi) for large enterprises operating in the 27 EU countries, we conducted their linear ordering using the MOORA method, considering the value of the aggregate variable. Consequently, typological classes were indicated, presenting the division of large entities due to their involvement in the process of sustainable and effective management of ICT resources, which contributed to the implementation of environmental goals following the CE concept. Table 5 presents the analysis results.

Based on the conducted research, we may conclude that solutions enabling the retention of the added value of ICT tools for as long as possible and the prevention of waste generation or reduction in the amount of waste generation in large enterprises are being introduced gradually. Therefore, the management of ICT equipment aimed at closing their life cycle, consisting of the use of waste gener-

ated in the process of functioning of devices and materials, reducing the consumption of raw materials, reducing waste, and multiplying the stream of waste used in recovery and recycling among the surveyed enterprises, is characterized by different intensity and slow action (see Figure 3).

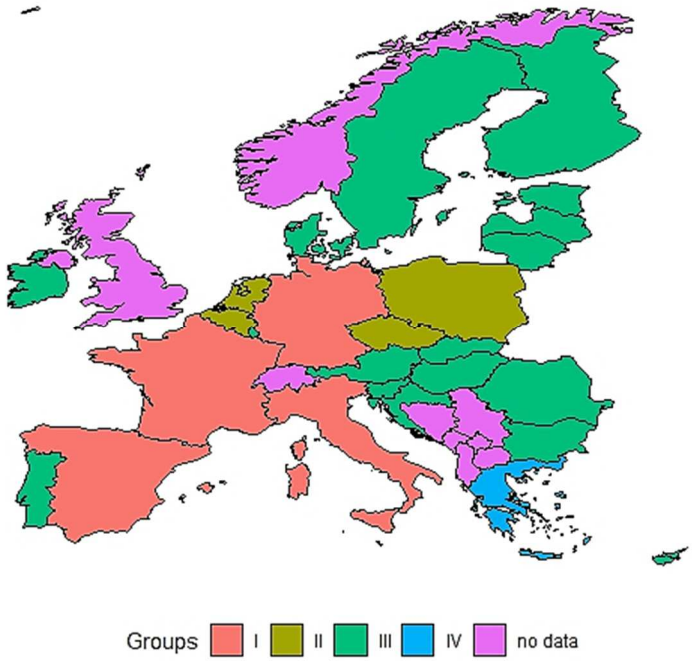


Figure 3. Classification of large enterprises according to the level of circularity of ICT equipment
Source: own elaboration in the RStudio software.

According to the conducted research, large entities located in the 'Old EU' (EU15) in DE, FR, ES, and IT were classified in typological class I and were simultaneously characterized by a very high level of sustainable management of ICT equipment (synthetic measure at the level of ≥7.509). Such enterprises in the above-mentioned countries displayed a very high digital intensity indicator (X17, DE – 18.6%; FR – 7.6%; ES – 18.9%; IT – 19.9%) and a significant indicator of circular use of materials (X18, DE – 13%; FR – 19.3%; ES – 7.1%; IT – 18.7%).

On the other hand, a high level of repair, recycling, and reuse, as well as effective management of waste resulting from the abandonment of ICT equipment use, was recorded by large enterprises operating in Central Europe (PL, CZ) and Western Europe (NL, BE) classified in typological class II. This type of community displayed a high index of the analysed variables, due to the value of the synthetic measure, which was within the range of 7.509-3.037. Large entities grouped in class II were characterized by a high degree of ICT equipment utilization within the collection/recycling of electronic waste (X11, PL – 85.5%; NL – 81.4%; CZ – 95.9%; BE – 90.4%), a significant indicator of circular use of materials (X18, NL – 27.5%; CZ – 11.9%; BE – 22.2%; PL – 8.4%) and a very high digital intensity indicator (X17, PL – 15.7%; NL – 12.7%; CZ – 17.4%; BE – 19%).

The most numerous class III was characterized by an average level of actions taken in connection with maintaining the value of ICT resources for as long as possible and minimizing waste in the process of closing material loops in the surveyed enterprises. Entities operating in 18 EU countries were classified in this grouping. According to the value of the synthetic measure, which was at the level of 3.037-(-1.435), large enterprises displayed an average degree of actions influencing the consumption of paper or energy by ICT equipment (X6). Moreover, used devices of this type are not sold, donated, or returned to the leasing company by the surveyed entities.

The extreme IV typological class includes large enterprises operating in the GR area representing Mediterranean Europe, which has achieved the lowest possible level of ICT resource utilization through the process of sharing, reusing, refurbishing, and recycling. This type of situation is indicated by the negative value of the synthetic measure (-1.435). The entities studied were characterized by one of the

lowest values of the digital intensity measure (X17 – 7%) and the circular use of materials indicator (X18 – 3.1%).

According to the research results, we may conclude that large enterprises located in the EU do not particularly undertake activities related to the effective management of ICT devices. Their conduct in the field of the circularity of ICT equipment is characterized by an average pace. This type of circumstance is confirmed by the conducted MOORA ranking, in which large enterprises from 67% of EU countries represent an average level of sustainable management of ICT devices. In addition, unused ICT equipment is stored (X12) in 58.4% of large enterprises or is not subject to sale, donation, or return to the lessor (X15) in the case of 46.9% of entities. On the other hand, following the purpose of the directive used electronic equipment should have been returned, disposed of, and recycled at a level of 65% already in 2019, and in 2030 it should be completely at 100% (Directive 2012/19/EU, 2012). In response to this unrealized intention, the European Commission has committed to presenting an 'initiative on closed-cycle electronic devices' in line with its sustainable products policy (COM/2020/98, 2020).

In the next research stage, the uneven distribution of large enterprises located in the EU that considered their impact on the environment before choosing ICT services and equipment was also determined. The Gini coefficient value was 0.6168. Therefore, we may conclude that there was significant inequality and great diversity among large entities in the selection of ICT devices from the perspective of their impact on the environment. Moreover, the Lorenz concentration curve illustrates the high level of differentiation (see Figure 4).

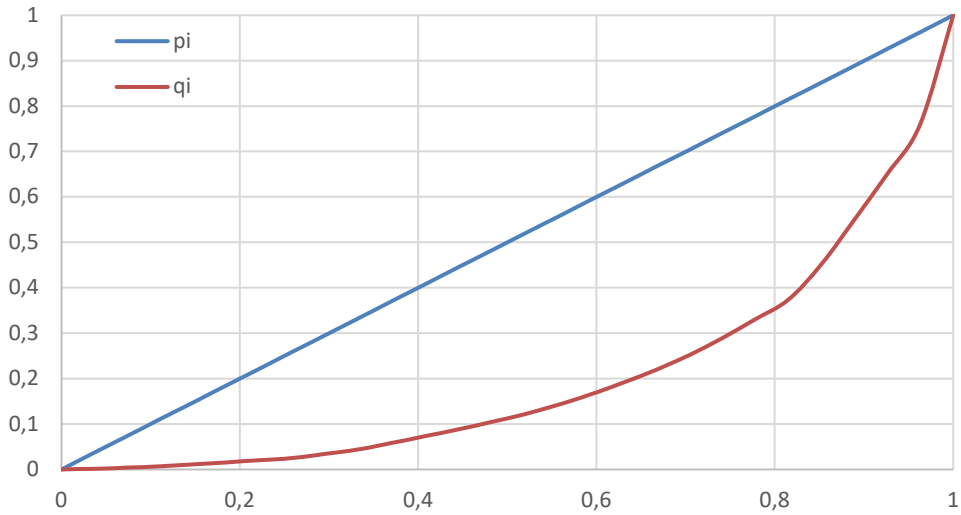


Figure 4. Lorenz curve
Source: own elaboration in the RStudio software.

The Lorenz curve shows the percentage distribution of large enterprises in relation to their cumulative share in the process of fully respecting the impact of ICT devices on the natural environment before their use. Thus, it shows the disproportions between the highest and the lowest level of involvement of entities in the selection of appropriate equipment from the perspective of environmental sustainability in the 27 EU countries. According to the calculated Gini index, we may divide large enterprises located in the EU into three groups according to the level of differentiation of the examined variable.

The first group with a high level of differentiation in the selection of ICT devices due to their environmental impact includes large enterprises operating in DE, FR, IT, and ES. These entities achieved high values on the Lorenz curve and low values of the pi and qi indices, suggesting that they are significantly involved in the selection of pro-environmental ICT tools.

The second group consisted of the surveyed companies with an average level of variable differentiation located in AT, SE, CZ, NL, RO, PL, HU, BE, PT, IE, SK, BG, FI, LT, GR. They occupy a central position on the Lorenz curve and have an average value of the pi and qi indices. Therefore, they are

distinguished by a moderate involvement in the appropriate selection of ICT devices from the perspective of reducing their negative impact on the environment compared to the previous group of companies.

The third class included large enterprises with a low level of differentiation in the choice of ICT equipment in terms of its impact on the environment. Entities of this type are located in MT, CY, EE, LU, HR, LV, SI, DK and are located close to the beginning of the Lorenz curve. In addition, they have low values of the pi and qi indices. This type of situation means that large entities in the indicated countries consider the impact of the environment when choosing ICT equipment but to a lesser extent than enterprises from the high and medium differentiation group.

The last stage of the research concerned the analysis of the degree of involvement of large enterprises in activities related to the application of pro-ecological solutions necessary for creating a circular model of selecting ICT equipment in accordance with the implementation of the SD concept. We initiated the diagnosis was initiated by plotting points on the plane for variables characterizing the digital intensity level indicator (DII – X) of large enterprises, which, before selecting ICT equipment, took into account its impact on the environment and took actions related to reducing energy and paper consumption (sICT – Y). Then, we fitted a straight line (trend line) to the obtained data in accordance with the formula Y=aX+b, where (aX) denoted the slope of the line, (b) reflected the slope of the line.

To assess the strength and direction of the relationship between variables X and Y, we used the R2 coefficient (Pearson's linear correlation coefficient squared), which takes values from the range [-1;1]. We compared the obtained results with the classification proposed by J. Guilford, according to which (Chicco & Jurman, 2020):

$|r| = 0$ – no correlation
$0.0 < |r| \leq 0.1$ – correlation is weak
$0.1 < |r| \leq 0.3$ – weak correlation
$0.3 < |r| \leq 0.5$ – average correlation
$0.5 < |r| \leq 0.7$ – high correlation
$0.7 < |r| \leq 0.9$ – very high correlation
$0.9 < |r| < 1.0$ – almost complete correlation
$|r| = 1$ – full correlation
in which: r – correlation coefficient between variables.

The correlation coefficient between the procedure for selecting ICT equipment, considering its savings, efficiency, and environmental impact, and the level of application of digital technologies for the surveyed enterprises with very high analysed indicators was 0.943. According to J. Guilford's division, we should conclude that the variables were closely dependent on each other because the correlation was almost complete. Entities with high intensity for the sICT and DII parameters had a correlation coefficient of 0.420. Thus, there was an average linear relationship between the surveyed variables. The R2 coefficient of enterprises characterized by low intensity was 0.904. Therefore, the level of dependence between random variables was very high. On the other hand, among entities with very low intensity of the surveyed features, the correlation was 0.930. Therefore, we should consider that there was a statistically significant, almost complete relationship. Such connections mean that with the increase in digital intensity, the degree of pro-ecological awareness of entities regarding the selection and application of ICT devices increases. Such activities contribute to the implementation of SDGs and the creation of a circular model for managing ICT equipment.

According to the research conducted, the slope coefficient (a) assumed variable values, which were at the level of 0.697 for a very high variable (x) to 0.315, indicating large enterprises with very low digital intensity. The slope coefficient determined for the analysed variables, which assumes the value of 0.697, characterizes enterprises distinguished by a very high digital intensity index, which, before choosing ICT equipment, considered its impact on the environment, including paper and energy consumption. Thus, if the level of very high digital intensity of large entities is increased by 10%, it will contribute by 69.7% to the intensification of activities aimed at a more favourable selection of ICT devices considering the assumptions of the CE concept.

Enterprises with a high (0.559) and low (0.533) digital intensity index also stood out with a high coefficient due to their adherence to a pro-ecological approach when choosing ICT equipment. If such enterprises strive to increase the DII index by 10%, there will be an intensification of ecological activities related to the choice of ICT equipment and the optimization of energy and paper consumption of 55.9% and 53.3%, respectively.

In turn, for large enterprises with very low digital intensity, the slope of the straight line reached the value of 0.315. Therefore, if the level of digital intensity increases by 10%, the pro-ecological awareness of the surveyed entities in terms of the appropriate choice of ICT equipment will increase by 31.5%.

Based on the conducted research, we determined ranges for individual categories of the digital intensity indicator due to the level of pro-ecological awareness of large enterprises when choosing ICT equipment, taking into account paper and energy consumption. Thus, the analysed X and Y indicators provided information on the level of activities undertaken by entities as part of the implementation of the SD concept and the creation of the CE model. To determine the ranges, we built an interval distribution series, in which we grouped the data according to specific value classes. We used this type of method due to the significant amount of data, for which analysis without taking into account the previous ordering was problematic. In accordance with the procedure for creating an interval distribution series, we assigned partial numbers to variants of features grouped into ranges, which are adequate to the variants classified into class ranges (Chattamvelli & Shanmugam, 2023). Based on the conducted analysis, we established the ranges of pro-environmental involvement in the process of selecting ICT equipment (PESE) for variables x and y with unnoticeable indicators at the level of 0.0 to 0.19, poor from 0.20 to 0.39, average from 0.40 to 0.59, high from 0.60-0.79 and very high from 0.80 to 1 (see Figure 5).

Figure 5. Distribution of pro-environmental commitment in the ICT equipment selection process
Source: own elaboration.

According to the CE assumptions, large enterprises should similarly strive to increase the level of digital intensity and the degree of selection of ICT equipment, considering its impact on the natural environment, so that the slope of the straight line reaches a value close to 1. Then, such entities will be fully engaged in the process of creating circular management of ICT devices and thus applying a closed cycle for this type of equipment.

However, if the coefficient (a) takes a value within the range of 0, it should be concluded that the level of digital intensity will not affect the selection of energy-efficient and environmentally friendly ICT devices. This indicates that large enterprises did not undertake pro-ecological actions related to the selection of ICT equipment in accordance with the SD concept consisting in the transition from a linear to a circular business model.

The conducted research shows that 70% of large enterprises with a very high digital intensity index have considered the impact of ICT equipment on the environment and have reduced the energy and paper consumption of these devices. Thus, such entities have a high PESE index. 56% of the surveyed entities with a high degree of digital intensity, when choosing ICT devices, drew attention to its pro-ecological significance in implementing the principles of the circular economy. Therefore, they have achieved an average level of the PESE index. Noteworthy, over half of large enterprises (53%) with a low digital intensity index have taken action to implement a closed loop in the selection of ICT devices. Despite this, they have achieved an average range of the PESE index, just like the entities from the previous group. In turn, 32% of organizations with a very low digital intensity index consider the impact of ICT equipment on the environment from the perspective of reducing energy and paper consumption. Their PESE index is at a low level.

Based on the EU CE action plans announced so far and recommendations on recycling devices, the pro-environmental involvement indicator in the selection process of ICT equipment should be between

0.75 and 0.85. The conducted research shows that most large enterprises currently have a low/unsatisfactory level of the analysed indicator and thus have not achieved the assumed strategic goals in the field of CE concerning the sustainable and pro-environmental selection of ICT equipment.

The results of the study show significant differences in the advancement level in the circular management of ICT equipment. This case also confirms previous analyses regarding the differences in the implementation of circular economy principles depending on the country of location of large enterprises. In DE, FR, and ES, organizations are distinguished by their significant involvement in taking pro-ecological actions. Such behaviour results from the immediate adaptation and implementation of EU policies supporting sustainable development (Diaz & Baumgartner, 2024; Drofenik *et al.*, 2025). In turn, entities operating in GR and CY, which occupy lower positions in the MOORA ranking, experience difficulties in implementing circular solutions due to the slower pace of development of the circular economy model, which is also confirmed by research by other authors (Govindan, 2023). However, the growing interest in the pro-ecological use of ICT equipment is noticeable in organizations with a higher digitalization level (including DE). For this reason, the key factors in the development of circular economy activities concerning ICT equipment are legal regulations and awareness-raising initiatives (Santarius *et al.*, 2023; Charfeddine & Umlai, 2023). Studies also indicate significant inequalities in the level of advancement of activities related to closed circulation. Therefore, the authors of previous studies propose the unification of legal regulations in the EU (Baran, 2019). Moreover, some of them point to the high costs of transforming enterprises towards a circular economy model (Bocken *et al.*, 2016). They also expose the insufficient resources of enterprises, which prevent the implementation of technological innovations (Geissdoerfer *et al.*, 2017).

The conducted research allowed us to verify the thesis, which indicates that, despite the adoption of uniform EU legal regulations, large enterprises still experience differences in the level of use and circularity of ICT equipment and their adaptation to SD criteria under the principles of selection, repair, recycling, reuse, and management of green ICT resources. This affects the effectiveness of closing material loops in the circular economy model.

CONCLUSIONS

The research presented in this article on large enterprises operating in the 27 EU countries allowed us to determine the level, degree, and pace of circularity in the process of selecting, using, repairing, recycling and reusing ICT devices. Based on this research, we can conclude that large entities partially narrow the material loop, which results from the rational management of ICT equipment. They currently use technological resources in accordance with the 3R principle, in connection with which they only implement the first and last assumption, *i.e.*, reduce and recycle.

To reduce waste resulting from the use of ICT devices, they use certain measures that affect the paper or energy consumption of ICT equipment (X5 and X6) or select equipment before purchase, considering its impact on the natural environment (X7 and X8). Furthermore, companies with a very high digital intensity factor consider both of the above criteria (X10). In terms of implementing the last principle, large companies dispose of unused ICT equipment based on the collection or recycling of electronic waste. Thus far, entities operating in the EU have not included the reuse of ICT devices under the second principle of reuse.

Studies have also shown that large enterprises display a varied degree of circularity and resource efficiency in the adopted model of managing ICT equipment. The highest intensity in the process of closing material loops is distinguished by entities located in the old EU, *i.e.*, in DE, FR, and ES. On the other hand, the lowest scope of minimizing the use of raw materials and waste generation is distinguished by enterprises also located in the old EU (GR, LU) and CY, located in the eastern part of the Mediterranean Sea.

Based on the constructed synthetic measure, we prepared a ranking presenting the level of circularity of ICT equipment in the surveyed enterprises. A very high level of circulation of raw materials and materials is characteristic of entities operating in the old EU (4 countries). An

identically high scope is also distinguished by large enterprises from Western Europe (2 countries) and Eastern Europe (2 countries). The average level is represented by entities operating in 18 EU countries. On the other hand, a low level of closing material loops is characteristic of the surveyed enterprises from one country in Southern Europe.

The Gini coefficient, with a value of almost 62%, also confirmed the significant diversification in the implementation of principles influencing the creation of a circular model of ICT equipment management in large enterprises. Thus, the conducted research indicates a non-identical state of involvement and awareness of entities in activities related to the implementation of the new circular economy model. Moreover, the developed indicator of pro-environmental involvement in the process of selecting ICT equipment is low. Therefore, we should recognize that, for large enterprises, activities related to minimizing the consumption of raw materials, waste generation, reduction of greenhouse gas emissions, and reduction of the level of energy use, which are related to closing the process loop, do not constitute their strategic goals. Currently, contrary to the legal regulations in force in the EU, the CE model is not a key direction of action included in the business strategies of the entities studied. Nevertheless, we should consider the use of procedures aimed at rationalizing the consumption of paper and electricity and recycling ICT devices as positive behaviours of selected enterprises.

Based on the conducted research, we recommend intensifying activities for the circular economy in EU countries, especially in the area of closing the material cycle, recycling, and reusing ICT equipment. Countries with a high level of circularity (Germany, France, Spain) should develop technological innovations and transfer knowledge to countries with a lower level of advancement.

In Central and Western European countries (including Poland and Belgium), it is necessary to increase the share of reusing materials and to educate and support the adaptation of national laws and regulations to EU guidelines and standards regarding the circular economy. On the other hand, countries with an average level, representing the majority in the EU, should invest in the waste management system and infrastructure necessary for waste processing and introduce economic support mechanisms for enterprises.

Countries with the lowest level of circularity (Greece, Cyprus) require the modernization of waste management systems and the adaptation of national laws and regulations to EU requirements. It is also necessary to take appropriate actions within the EU structures, such as harmonizing regulations, increasing activity in the implementation of the principles of the circular economy, and exchanging good practices to achieve the objectives of the directives by 2030.

The conducted research has limitations resulting, in particular, from the short time horizon and data availability. Thus far, such research has not been conducted. Eurostat collected data on ICT and the environment for the first time in 2022. Therefore, we recommend continuing the research in the future in a longer time horizon to compare the effectiveness of the CE model implementation from the perspective of the effectiveness of ICT equipment management in all groups of enterprises.

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Acknowledgements and Financial Disclosure

The authors would like to thank the anonymous referees for their useful comments, which allowed to increase the value of this article.

Use of Artificial Intelligence

The authors declare that the submitted text is free of AI/GAI usage. All content has been prepared solely by the authors without the assistance of generative tools.

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International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.05

A thirty-year evolution of enterprise resilience research: A scoping review

Sylwia Bąk

ABSTRACT

Objective: The article presents a scoping review of the literature on enterprise resilience covering the last 30 years.

Research Design & Methods: I conducted the research in a qualitative-quantitative convention. I based the research methodology on the requirements of the scoping review method, with the support of the recommendations resulting from PRISMA-ScR. I used a one-step logical classification method to create the categorization of the scope. To ensure the review's comprehensiveness, I also conducted a visual analysis of the obtained findings, in terms of both scope definition and keywords analysis.

Findings: The review allowed me to outline and categorise the scope of the literature dedicated to enterprise resilience. Of the 2117 publications searched, 454 met the inclusion criteria. Furthermore, I identified 1727 keywords, of which I selected 128 for analysis. I categorised the texts qualified for analysis under seven scope categories and grouped the analysed keywords into twelve clusters. The largest percentage of the texts fell into the scope category called 'building a resilient enterprise.'

Implications & Recommendations: I identified a definite shortage of texts on resilience strategies and mechanisms for measuring resilience, the proportion of which in the set of reviewed texts was far lower than expected. Therefore, these areas should determine the direction of future research. The results of the scoping review show implications for the development of theories concerning the identification of as yet unexplored research gaps and for applications in terms of providing a compendium of knowledge on good pro-resilience practices for enterprises across different sectors.

Contribution & Value Added: This article is a contribution to research on enterprise resilience. Thanks to the adopted scope of analysis, the number of included texts, the methodological approach and the synthesis of results, it fills the identified research gap and reliably presents a comprehensive scope of the literature in this area.

Article type:	research article
Keywords:	enterprise resilience; organizational resilience; business resilience; resilient enterprise; resilient organization
JEL codes:	D81, H12

Received: 29 August 2024 | Revised: 8 April 2025 | Accepted: 18 April 2025

Suggested citation:
Bąk, S. (2025). A thirty-year evolution of enterprise resilience research: A scoping review. *International Entrepreneurship Review,* 11(3), 93-131. https://doi.org/10.15678/IER.2025.1103.05

INTRODUCTION

Enterprise resilience is currently a very important and widely explored research topic all over the world. The intensification of the demand for scientific evidence on building, strengthening, and managing business resilience has been noticeable particularly since the outbreak of the global pandemic crisis (Acciarini *et al.*, 2021). Other reasons for business organizations' greater need for knowledge and skills in creating resilience mechanisms include an increasingly unstable and chaotic business environment (Kantur & İşeri-Say, 2015), uncertainty and risk inherent in most business activities (Ma *et al.*, 2018) and, exposed by previous crises, the unsatisfactory preparedness of enterprises across different sectors for potential crises of various nature, course and intensity (Chen *et al.*, 2022).

LITERATURE REVIEW

The dynamised demand for research on business resilience naturally results in a rapidly growing number of scientific texts addressing this research issue, both publications presenting empirical evidence and review studies.

At present, the scientific literature includes several broader or narrower thematic reviews of research on the issue of enterprise resilience. Concerning texts not restricted to individual sectors and not exclusively related to resilience in the context of a single event/crisis (*e.g.*, the COVID-19 pandemic), there are reviews juxtaposing organizational resilience with other important aspects of business activities such as corporate sustainability (Abdullahi *et al.*, 2023; Ciasullo *et al.*, 2024; Florez-Jimenez *et al.*, 2024) leadership (Gichuhi, 2021; Istiqaroh *et al.*, 2022), or business continuity (Ostadi *et al.*, 2023). There are only a handful of overview texts on a broad range of enterprise resilience issues that do not focus on specific events or business sectors. These are mainly systematic literature reviews (Barasa *et al.*, 2018; Linnenluecke, 2017; Rydzewski, 2024). There are even fewer scoping reviews, which are responsible for indicating the scope of the literature on enterprise resilience. There are some scoping reviews concerning this research area, but they are usually limited in some respect, for example in terms of sector (Bento *et al.*, 2021).

Therefore, there is a clear research gap regarding the lack of a comprehensive (in terms of time and content) review of the scope of research topics related to the issue of enterprise resilience. Intensive research explorations are needed in this area, which will reflect the process of evolution of methodologies for building and maintaining enterprise resilience and will allow for understanding the justification for conducting increasingly intensive research in this area.

Given the above outline of review texts on organizational resilience, this article aims to conduct a scoping review of the literature on enterprise resilience (without restrictions concerning individual sectors or crises), covering the last 30 years, *i.e.*, from the introduction of the concept of enterprise /organizational resilience in the literature in 1994 to the present. There are no such scoping reviews in the publicly available scientific literature. Therefore, this article aims to fill the identified research gap. Furthermore, the literature review method based on a scoping review is extremely important in many fields and disciplines of science (including social sciences) and makes it possible to identify scientific achievements and outline the evolutionary stages of particular research topics (Sharma & Goyal, 2023), which positively influences the development of individual fields of science and the determination of future research directions.

Thanks to this research method, the study I have planned on the scientific exploration of the topic of enterprise resilience can make a significant contribution to the development of management sciences, both in theoretical and practical terms; firstly, by filling the literature gap and increasing scientific awareness, and secondly, by providing management practitioners with information on resilience mechanisms, which is sorely needed in today's turbulent economic environment. The current state of enterprise resilience is unfortunately not satisfactory, as revealed by, for example, global crises (economic, social, geopolitical, environmental). Therefore, for enterprises to be able to better cope with strengthening their resilience mechanisms, the world of science and business currently needs, among others, research such as the results of which I have presented in this text (of a review, bibliometric, synthesizing nature, integrating theoretical and practical threads).

Concerning the above-stated objective, I posed three leading research questions:

RQ1: How have trends in enterprise resilience research evolved?

RQ2: What global events have determined changes in research on enterprise resilience over the past 30 years?

RQ3: What are the key areas of the scope of research on enterprise resilience?

The following sections discuss the methodology of the conducted scoping review, indicating the research approach and methods, the detailed search strategy together with the inclusion and exclusion criteria. Next comes the presentation of the results of the scoping review with particular emphasis on

search results, keyword analysis, scope, and discussion of the scope. The final part of the text contains the main conclusions of the performed analyses together with their implications, limitations and an outline of directions and recommendations for future research on business resilience.

RESEARCH METHODOLOGY

Research Approach and Methods

I based this literature review on a mixed (qualitative-quantitative) approach. I used a triangulation of research methods to find answers to the research questions posed. The main method used in the research procedure was a scoping review, a method that has already been recommended for many years for thematic literature reviews and the mapping of gaps in the existing knowledge of a specific topic. In the course of the conducted review, I applied all the requirements of the methodological rigour associated with the use of this method (Arkasey & O'Malley, 2005; Levac, 2010).

To ensure the review's integrity and transparency and to obtain reliable and conclusive results, I conducted the study in a manner consistent with the preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) checklist (Tricco *et al.*, 2018).

To develop the categories of the scope of the research area under examination, I used a one-step logical categorization method, with the simultaneous fulfilment of the exhaustiveness and separability criteria required by the rigour of this method (Bailey, 1994; Saran, 2014).

Numerous graphical visualizations and elements of bibliometric analysis complement the review (Jadil *et al.*, 2021; Marzi *et al.*, 2024) as an integral part of a scoping review. The visual results of review studies are extremely useful to clearly present relationships between the various major features of articles undergoing analysis (authors, dates, keywords, *etc*.) (Kumar *et al.*, 2022). I largely developed the visualizations using the VosViewer version 1.6.20 software tool.

The research process was divided into the following stages:

1. Establishing a research objective and formulating research questions.
2. Defining a search strategy.
3. Selecting articles (determining inclusion and exclusion criteria).
4. Extracting and analysing data.
5. Presenting search results.
6. Analysing keywords.
7. Categorizing the scope of the qualified texts.
8. Discussing the developed scope.
9. Summarizing and reporting results.

Search Strategy

For the review to meet the reliability conditions, I looked for relevant texts in three respected databases accumulating scientific texts in the fields of management and economics, namely EBSCO, Scopus, and Web of Science. Basing the search on the results of as many as three databases dramatically reduced the risk of omitting important scientific texts that met the adopted inclusion criteria. In the first step of the search, I established a list of search terms. I searched for these terms at the level of article titles. Based on the established list of search terms and the specifications of the individual databases, I developed search queries used to properly search the databases. Figure 1 shows the search strategy.

Article Selection

I searched the databases on 28 June 2024. I selected the texts retrieved using the strategy shown in Figure 1 based on the established inclusion criteria. The inclusion criteria were as follows: 1) peer-reviewed texts, *i.e.*, articles published in scientific journals or peer-reviewed conference proceedings, 2) texts in English, 3) texts available in Open Access (I adopted this criterion due to the nature of a scoping review. This is because the development of a scope very often requires reading a full text).

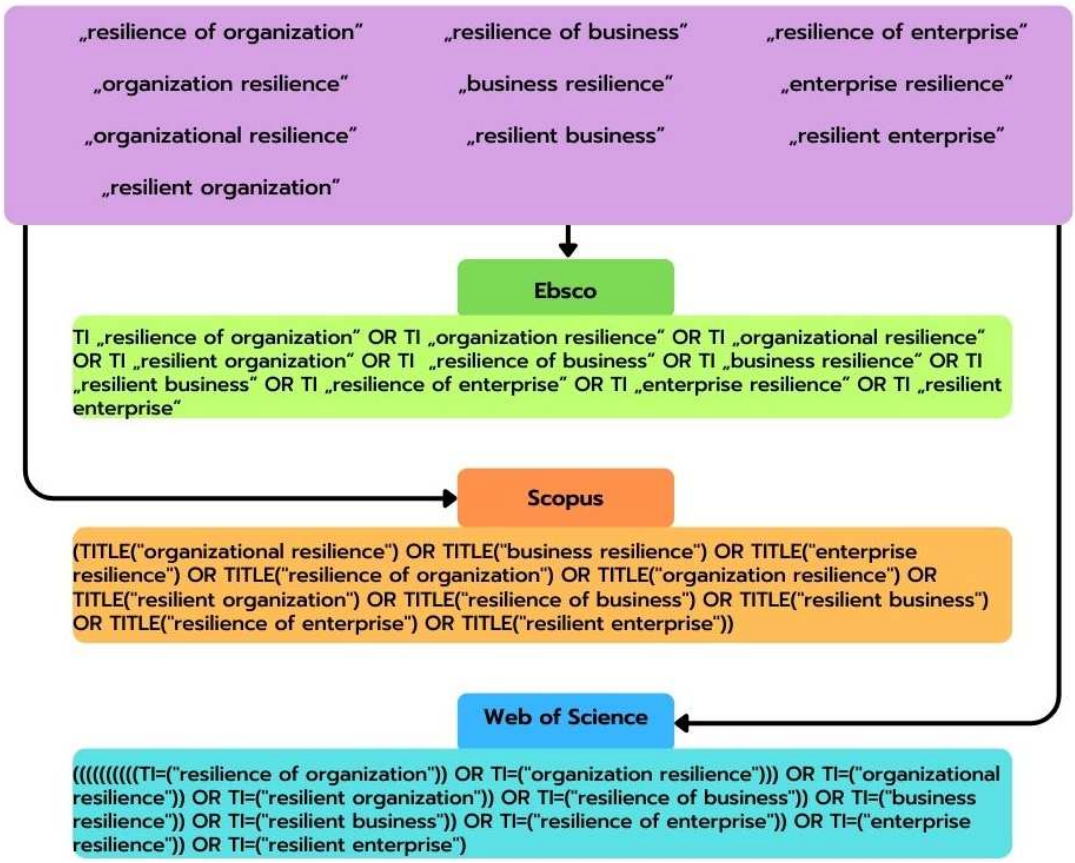

Figure 1. Search strategy
Source: own elaboration.

I applied the above inclusion criteria for the texts retrieved from each of the databases using the filters available in them. Subsequently, I downloaded the results of applying the inclusion criteria to the texts from each database in the .ris format and transferred them to the Mendeley software. For each text, I extracted data such as title, author, year of publication, journal/conference name, abstract, keywords and a reference to the full text (doi no./link).

In the next step, I cleaned the total text base obtained after applying the inclusion criteria to each database of duplicate items. The resulting reduced number of texts was subjected to further content analysis. I analysed the abstract of each text and, on this basis, established an exclusion criterion to remove texts with specific subject matters unrelated to enterprise management issues. I approved the texts remaining after this elimination for the final analyses aimed at the development of the scope of the literature.

Data Extraction and Analysis

I subjected the set of texts obtained in the previous step to appropriate analyses concerning their keywords and scopes:

1. Keywords analysis: I analysed the database of the keywords of all the finally shortlisted texts using the tools offered by the VosViewer software. In the first step, I manually cleaned the resulting keyword list of items not relevant to the research objective. The resulting list underwent a further substantive and chronological analysis. To make effective use of the keywords analysis results in the scoping review, I considered the repeatability of the keywords as a criterion of representativeness supporting the definition of the scope category in the next step. Therefore, I qualified all keywords repeated in three or more texts for further analyses. I grouped them into thematic clusters preliminarily outlining the scope of the topic under analysis. Another factor facilitating the deter-

mination of the scope was the presentation of the keywords in the order of their frequency of appearance in the texts, within the network of links between them and in chronological order. When analysing the network of links between keywords, I used VosViewer weight attributes such as 'links' (allowing to assess of the number of links of an item with other items) and 'total link strength' (allowing to assess the total strength of the links of an item with other items).

2. Scope: to finalise the scope categories of the texts, I analysed each text concerning substantive content based on abstracts. When the information presented in an abstract was not sufficient to classify a text into the scope category, I analysed it in its entirety.

Figure 2 details the study selection process.

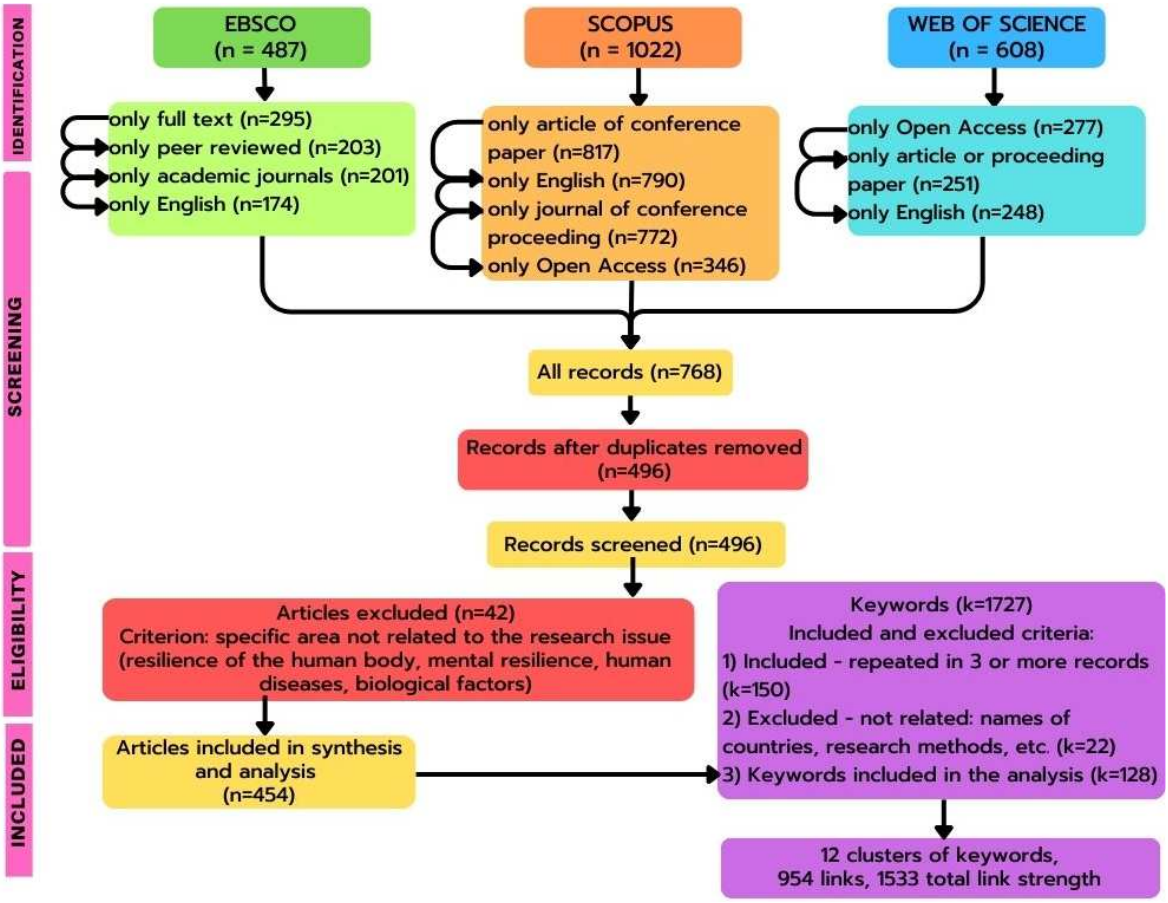

Figure 2. A flow chart of the study selection process
Source: own elaboration.

RESULTS AND DISCUSSION

Search Results

After applying the search strategy with no time restrictions relating to publication dates (Figure 1), I searched a total of 2117 texts in the three databases (EBSCO: 487, Scopus: 1022, Web of Science: 608). After applying the filters reflecting the text analysis inclusion criteria (Figure 2), a total of 768 texts remained (EBSCO: 174, Scopus: 346, Web of Science: 248). After the removal of the same texts returned by the different databases, I accepted 496 texts for further analysis.

Next, following a detailed revision of all texts (at the level of titles and abstracts), I eliminated 42 texts whose subject matters were not compatible with the review's scope. These included texts on the resilience of the human body, mental resilience, human diseases, and biological factors. Eventually, 454 texts meeting the inclusion criteria remained to be properly analysed and synthesised.

The results of the searches showed that the first text related to enterprise resilience had been published in 1994. In the following years, the number of such texts was increasing slowly with a clear rise only from 2016 onwards (with a peak of 108 texts in 2023). Figure 3 presents a chronological distribution of the number of texts on enterprise resilience.

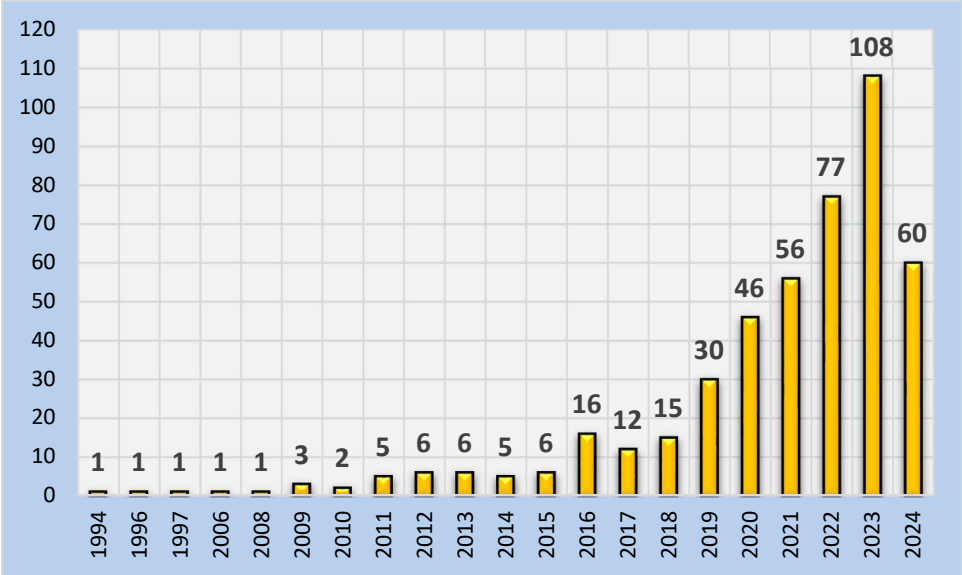

Figure 3. A chronological distribution of the texts included in the analyses
Source: own elaboration.

Keywords Analysis

I conducted a keyword analysis as a first step to determine the scope of the texts analysed. I identified a total of 1727 keywords in all texts selected for analysis. After applying the representativeness criterion (repetition of a keyword in three or more texts), the number of keywords qualified for further

Table 1. Keywords clusters

Total link strength	Occurrences	Keyword	Cluster	Keyword	Occurrences	Total link strength
9	4	adaptability	1	market turbulence	3	9
10	3	adaptive resilience	1	organizational learning capability	3	12
13	3	companies	1	organizational performance	5	14
8	3	complexity	1	organizational research	3	10
7	3	corporate culture	1	organizational resilience	414	227
59	18	dynamic capabilities	1	resilience capabilities	3	7
9	3	employee resilience	1	resource-based view	3	10
25	6	firm performance	1	SMEs	13	44
45	12	innovation	1	social media	4	10
18	6	business	2	management	7	25
12	3	business sustainability	2	organizational structure	3	6
17	4	capacity	2	performance	12	37
10	4	change	2	robustness	3	10
19	5	crises	2	safety	4	10
58	18	crisis	2	supply chain	4	15
6	3	digital innovation	2	tourism	9	23
41	14	digital transformation	2	vulnerability	4	11
10	5	digitalization	2			
35	12	adaptation	3	enterprise architecture	3	4
6	3	artificial intelligence	3	financial crises	3	11

Total link strength	Occur-rences	Keyword	Cluster	Keyword	Occur-rences	Total link strength
12	3	business model	3	organization	5	14
22	7	business models	3	resilience	92	208
33	9	business planning	3	sustainability	19	44
10	3	business strategy	3	sustainable development	9	26
6	3	climate change	3	technological innovations	3	8
17	4	adversity	4	organizational learning	13	32
29	7	decision making	4	pandemics	3	7
10	3	human resource management	4	personnel management	3	10
18	6	natural disasters	4	psychological resilience	9	28
9	3	nonprofit organizations	4	social capital	7	29
37	13	organizational change	4	transformational leaders	3	6
8	3	organizational effectiveness	4			
8	3	awareness	5	resources	3	11
10	3	capabilities	5	situational awareness	3	11
10	3	collective mindfulness	5	social impact	5	20
20	7	corporate social responsibility	5	social responsibility of business	5	18
33	12	leadership	5	stakeholder theory	3	11
13	4	mindfulness	5	stakeholders	3	13
83	27	crisis management	6	knowledge management	3	6
5	3	digital maturity	6	operational resilience	5	8
28	6	digital technology	6	organizational resilience	32	42
11	4	disruptions	6	pandemic	5	17
154	6	dynamic capability	6	strategy	6	23
8	3	enterprise risk management	6	uncertainty	5	12
38	11	business continuity	7	economic development	4	7
16	3	business continuity planning	7	entrepreneurship	6	19
6	3	competitive advantage	7	global financial crisis 2008-2009	4	11
6	3	critical infrastructure	7	risk management	11	34
13	3	cyber security	7	risk management in business	9	30
14	3	disaster recovery	7	strategic planning	6	23
7	3	business ethics	8	financial literacy	3	7
64	28	business resilience	8	government support	4	11
28	7	business people	8	information technology	6	22
94	34	covid-19 pandemic	8	small business	21	71
7	3	skills	9	industrial management	4	13
13	4	disasters	9	risk assessment	3	6
14	3	economic structure	9	covid-19	52	123
21	7	emergency management	9			
11	4	adaptive capacity	10	organizational behaviour	4	12
18	6	business enterprises	10	public sector	4	10
12	4	family business	10	work environment	4	9
19	6	family-owned business enter-prises	10			
6	5	resilience engineering	11	safety culture	3	3
19	7	risk	11	safety management system	3	6
36	19	enterprise resilience	12	preventive actions	3	5
8	3	preparedness	12	recovery	3	7

Note: The keywords in each cluster with the highest number of occurrences are marked in grey.
Source: own study.

analysis decreased to 150. I then manually cleaned the keywords of those that were irrelevant to the review, such as the country names or research methods mentioned in articles. At this stage, I discarded 22 keywords, so I approved 128 keywords for the actual analyses. Using VosViewer, I categorised the keywords into 12 thematic clusters. Each cluster showed network connections and relationships between the keywords within it. Altogether, I identified 954 links and 1533 total link strength between the keywords. Table 1 presents an analysis of the keywords clusters.

Figure 4 shows a keyword map considering the criterion of keyword intensity in the analysed texts.

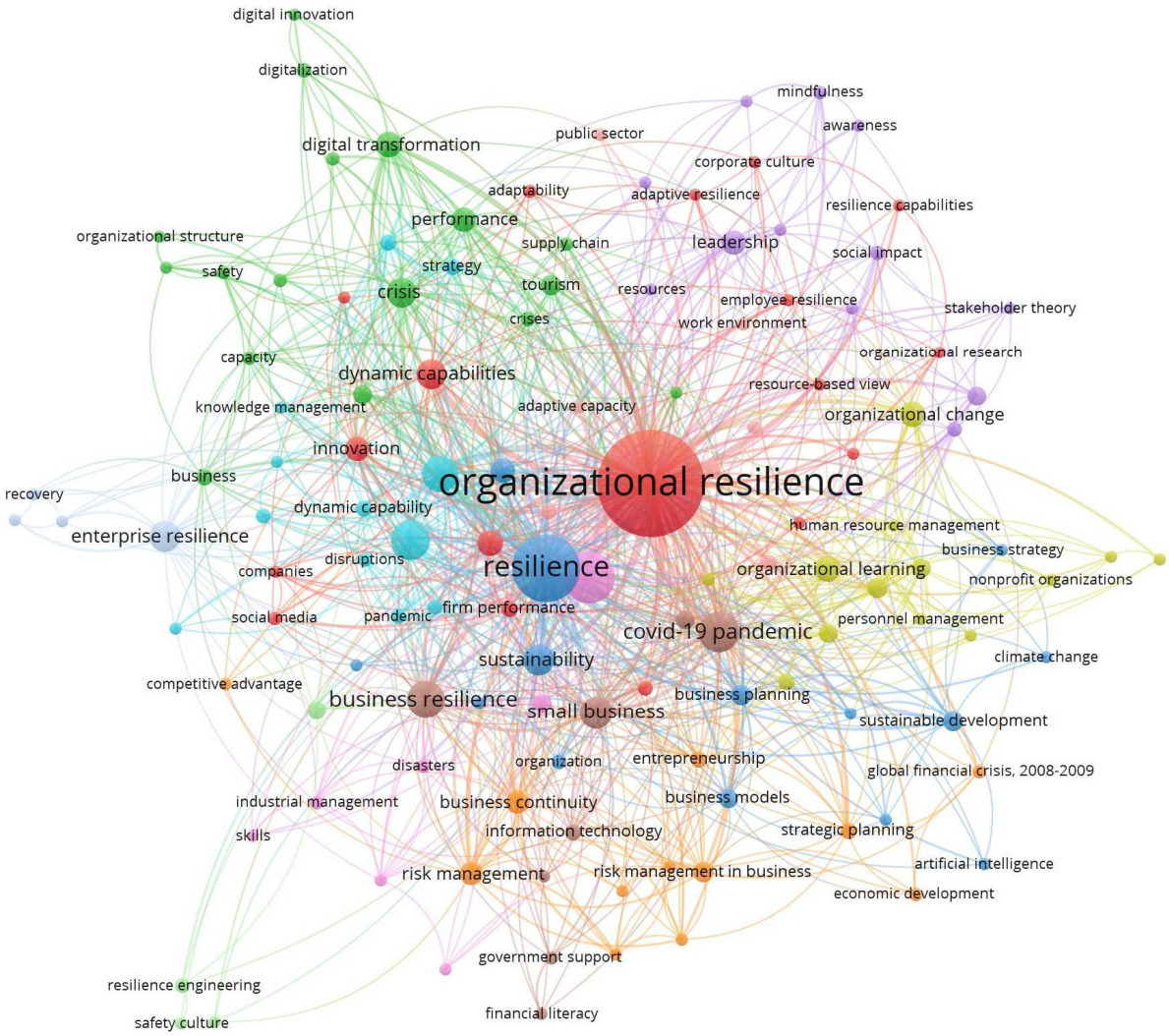

Figure 4. A keywords map (criterion: intensity)
Source: own elaboration in VosViewer ver. 1.6.20.

Figure 5 shows a map of the keywords considering the criterion of chronological order.

Scope

The central aim of this review was to identify and categorise the scope of the scientific literature on enterprise resilience. Based on detailed content analyses of the selected publication (abstracts and full texts), I created the following seven categories of the scope of the scientific literature addressing the issue of enterprise resilience (Table 2): 1) management tools for adaptation, survival and renewal during crises, 2) building a resilient enterprise, 3) strategies supporting enterprise resilience, 4) enterprise resilience in the face of global crises, pandemic and natural disasters, 5) assessment of organizational resilience, 6) concepts and attributes of enterprise resilience, 7) norms and standards related to enterprise resilience.

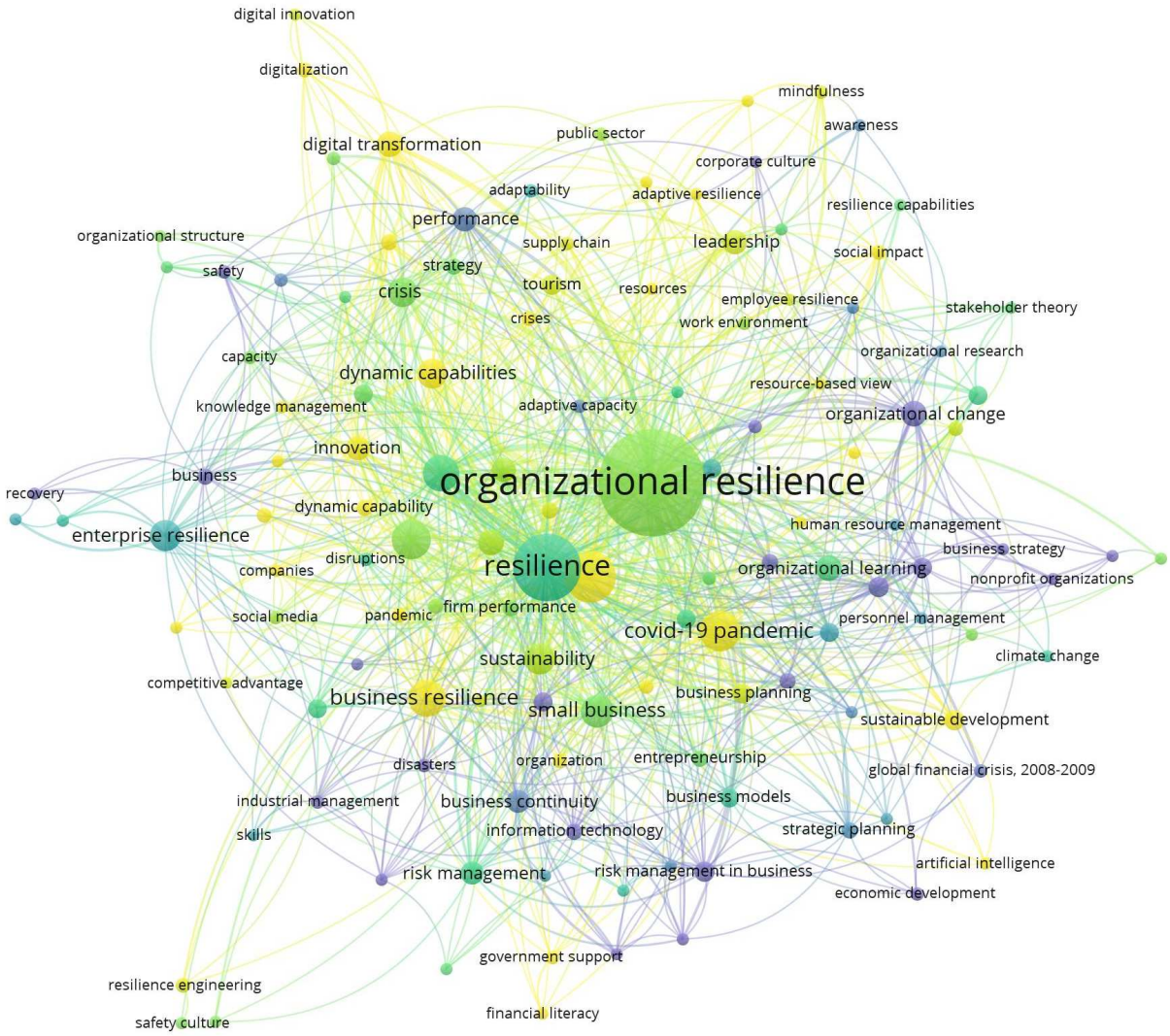

Figure 5. A keywords map (criterion: chronology)
Note: chronologically – from dark colour to light colour.
Source: own elaboration in VosViewer ver. 1.6.20.

Table 2. Scope categorisation

Category	Publications	No. of publ.	
		No.	%
Management tools for adaptation, survival and renewal during crises	(Acar & Winfrey, 1994); (Crichton *et al.*, 2009); (Danes *et al.*, 2009); (Lengnick-Hall *et al.*, 2011); (Bauernhansl *et al.*, 2012); (Koronis & Ponis, 2012); (Salanova *et al.*, 2012); (Lampel *et al.*, 2014); (Jaaron & Backhouse, 2014); (Sahebjamnia *et al.*, 2015); (Bhattacharjya & Ellison, 2015); (Gill *et al.*, 2016); (Ortiz-de-Mandojana & Bansal, 2016); (Chen, 2016); (Faeni, 2016); (Shuja & Abbasi, 2016); (Petruzzi & Loyear, 2016); (McEwen *et al.*, 2016); (Lafuente *et al.*, 2017); (Fisher *et al.*, 2017); (Sin *et al.*, 2017); (Allende *et al.*, 2017); (Burnard *et al.*, 2018); (Sahebjamnia *et al.*, 2018); (Nica, 2019); (Xu *et al.*, 2019); (Mohamed & Galal-Edeen, 2019); (Maria Beuren & dos Santos, 2019); (Sanchis *et al.*, 2020); (Beuren *et al.*, 2020); (Drossel *et al.*, 2020); (Tarken, 2020); (Accou & Reniers, 2020); (Ward *et al.*, 2020); (Campbell, 2020); (Mitsakis, 2020); (Liang & Cao, 2021); (Ewertowski & Butlewski, 2021); (Niemi *et al.*, 2021); (Sanchis *et al.*, 2021); (Dinu *et al.*, 2022); (Arias-Vargas *et al.*, 2022); (Kampmann & Pedell, 2022); (Sobczak, 2022); (Al-Matari *et al.*, 2022); (Do *et al.*, 2022); (Mahmoudi *et al.*, 2022); (Marcucci *et al.*, 2022); (Baghernezhad *et al.*, 2023); (Trieu *et al.*, 2023); (Liu *et al.*, 2023); (Lauri *et al.*, 2023); (Sincorá *et al.*, 2023); (Wang *et al.*, 2023); (Baird	78	17

	et al., 2023); (Frare *et al.*, 2023); (Lisdiono *et al.*, 2023); (Lv *et al.*, 2023); (Nielsen *et al.*, 2023); (Yilmaz Kozcu & Timurcanday Özmen, 2023); (Yamauchi & Sato, 2023); (Bragueto Martins & Frezatti, 2023); (Trim & Lee, 2023); (Mao *et al.*, 2023); (Rao *et al.*, 2024); (Cheng *et al.*, 2024); (Endaryono *et al.*, 2024); (Nguyen *et al.*, 2024); (Tucker & Alewine, 2024); (Eichholz *et al.*, 2024); (Weber & Kokott, 2024); (Jiao & Bu, 2024); (Monazzam & Crawford, 2024);(Wang & Zhao, 2024); (Shela *et al.*, 2024); (Huang *et al.*, 2024); (Marquez-Tejon *et al.*, 2024); (Bartel & Rockmann, 2024)		
Building a resilient enterprise	(Blohowiak, 1996); (Coullahan & Shepherd, 2008); (Levi *et al.*, 2011); (Fleming, 2012); (Andrés & Poler, 2013); (Carlisle, 2015); (de Carvalho *et al.*, 2016); (Wilson, 2016); (Frisbie & Converso, 2016); (Back *et al.*, 2017); (Dalgaard-Nielsen, 2017); (Jung, 2017); (Littlewood & Holt, 2018); (Velu *et al.*, 2019); (Bui *et al.*, 2019); (Sanchis & Poler, 2019b); (Al-Abrrow *et al.*, 2019); (Jiang *et al.*, 2019); (Lv *et al.*, 2019); (Li, 2020); (Bretos *et al.*, 2020); (Herbane, 2020); (Rehak, 2020); (Morris & Bowen, 2020); (Duarte Alonso *et al.*, 2020); (Yang & Cheng, 2020); (Annarelli *et al.*, 2020); (Bemthuis *et al.*, 2020); (Beech *et al.*, 2020);(Zablocka-Kluczka & Sałamacha, 2020); (Adekola & Clelland, 2020); (Tasic *et al.*, 2020); (Senbeto & Hon, 2020); (Kusumaputri *et al.*, 2021); (Cosentino & Paoloni, 2021); (Wang *et al.*, 2021); (Tuazon *et al.*, 2021); (Limphaibool *et al.*, 2021); (Miceli *et al.*, 2021); (Heinz *et al.*, 2021); (Badia *et al.*, 2021); (Jnitova *et al.*, 2021); (Njuguna *et al.*, 2021); (Haleem *et al.*, 2021); (Sarkar, 2021); (Pollifroni *et al.*, 2021); (Fietz *et al.*, 2021); (Rodríguez-Sánchez *et al.*, 2021); (Zhang *et al.*, 2021); (Biedenbach *et al.*, 2022); (Schipor (Frecea), 2022b); (Mai *et al.*, 2022); (He *et al.*, 2022); (Waerder *et al.*, 2022); (Onn *et al.*, 2022); (Kwiotkowska, 2022); (Mehedintu & Soava, 2022); (Wang & Chen, 2022); (Fleron *et al.*, 2022); (Setiaji & Pravitasmara Dewi, 2022); (Lisdiono *et al.*, 2022a); (Birthare & Bhargava, 2022); (Shan & Tian, 2022); (Logasakthi *et al.*, 2022); (Weis & Klarner, 2022); (Unguren & Kacmaz, 2022); (Gianiodis *et al.*, 2022); (Wang *et al.*, 2022); (Mumford, 2022); (Marzouk & Jin, 2022); (Ervina & Agoes, 2022); (Johari *et al.*, 2022); (Lisdiono *et al.*, 2022b); (Mafimisebi *et al.*, 2023); (April *et al.*, 2023); (Wang *et al.*, 2023); (Jones *et al.*, 2023); (Godfrey & Munoz-Chereau, 2023); (Dekoulou *et al.*, 2023); (Pescaroli, Guida, *et al.*, 2023); (You & Williams, 2023); (Buranapin *et al.*, 2023); (Tang et al., 2023); (Juliana *et al.*, 2023); (Zhou *et al.*, 2023); (Xie *et al.*, 2023); (Padmalia *et al.*, 2023); (Casprini *et al.*, 2023); (Janeckova, 2023); (Limon *et al.*, 2023); (Dryglas & Salamaga, 2023); (Gerschberger *et al.*, 2023); (García-Valenzuela *et al.*, 2023); (Sanusi *et al.*, 2023); (Butkus, Schiuma *et al.*, 2023); (Wu & Li, 2023); (Chen *et al.*, 2023); (Guo & Wang, 2023); (Hollands *et al.*, 2023); (Koh *et al.*, 2023); (Kotsios, 2023); (Hasayotin, 2023); (Dragomir *et al.*, 2023); (Hayat & Sadikin, 2023); (Benabed, 2023); (Abdelwahed & Basly, 2023); (Zhang *et al.*, 2023); (Buntić *et al.*, 2023); (April, 2023); (Gichuhi *et al.*, 2023); (Roach *et al.*, 2023); (Wozniak, 2023); (Wu & Tham, 2023); (Nurhayati & Astono, 2024); (Wang *et al.*, 2024); (Pekdemir & Günlü Küçükaltan, 2024); (Xu *et al.*, 2024); (Mellado-Garcia *et al.*, 2024); (Durst *et al.*, 2024); (Prayag *et al.*, 2024); (Al Mohannadi *et al.*, 2024); (Őri *et al.*, 2024); (Zadok *et al.*, 2024); (Dewi *et al.*, 2024); (Browder *et al.*, 2024); (Erda & Khurniawan, 2024); (Duan & Luo, 2024); (Garrido-Moreno *et al.*, 2024); (Wu & Li, 2024); (Adejumo, 2024); (Engelen *et al.*, 2024)	131	29
Strategies supporting enterprise resilience	(Horne III, 1997); (Sauser *et al.*, 2011); (Kachgal, 2015); (Church & Truitt, 2017); (Sapeciay *et al.*, 2019); (Herbane, 2019); (Niemimaa *et al.*, 2019); (Lecossier & Pallot, 2020); (Jivaasha, 2020); (Jalil *et al.*, 2021); (Kim, 2021); (de Moura *et al.*, 2021); (Quenum *et al.*, 2021); (Ahmić, 2022); (Barbosa Lavarda & Kopp Leite, 2022); (Heredia *et al.*, 2022); (Schulze & Bövers, 2022); (Pratono, 2022); (Huiskamp *et al.*, 2022); (Yu *et al.*, 2022); (Baghersad & Zobel, 2022); (Anugrah Pratama *et al.*, 2023); (Nkomo & Kalisz, 2023); (Bachtiar *et al.*, 2023); (Cekuls, 2023); (Pont & Simon, 2024); (Georgescu *et al.*, 2024); (Ruppenthal & Rückert-John, 2024); (Khalif & Slim, 2024)	29	6
Enterprise resilience in the face of global crises, pandemic and natural disasters	(Gittell *et al.*, 2006); (Branzei & Abdelnour, 2010); (Linnenluecke *et al.*, 2012); (Amann & Jaussaud, 2012); (Wicker *et al.*, 2013); (Glasser, 2016); (Moran, 2016); (Graveline & Grémont, 2017); (Tisch & Galbreath, 2018); (Bunney *et al.*, 2018); (Adeniyi *et al.*, 2019); (Ybarra, 2019); (Torres *et al.*, 2019); (Martinelli *et al.*, 2019); (Bang *et al.*, 2019); (Donnan *et al.*, 2020); (Pescaroli *et al.*, 2020); (Salvato *et al.*, 2020); (Salanova, 2020); (Fathy El Dessouky & Al-Ghareeb, 2020); (Huang *et al.*, 2020); (Skouloudis *et al.*, 2020); (Sharma, 2020); (Jia *et al.*, 2020); (González & Pérez-Uribe, 2021); (Madichie, 2021); (Rai *et al.*, 2021); (Sajko *et al.*, 2021); (Lin & Wen, 2021); (Aldianto *et al.*, 2021); (Paluszak *et al.*, 2021); (Martinelli *et al.*, 2021); (Sobaih *et al.*, 2021); (Kaçmaz & Çevirgen, 2021); (García & Alvarez, 2021); (Kong *et al.*, 2021); (Saputra &	109	24

	Grace Herlina, 2021); (Fleming, 2021); (Sundarakani & Onyia, 2021); (Schipor Frecea, 2022a); (Li *et al.*, 2022); (Beninger & Francis, 2022); (Zambrano *et al.*, 2022); (Liu *et al.*, 2022); (Ullah *et al.*, 2022); (Sadeqi-Arani & Ghahfarokhi, 2022); (Huang *et al.*, 2022); (Hamsal *et al.*, 2022); (Herrero & Kraemer, 2022); (Zhou & Yang, 2022); (Allen, 2022); (Adeniyi *et al.*, 2022); (Robertson *et al.*, 2022); (Brown *et al.*, 2022); (Zayed *et al.*, 2022); (Hadjielias *et al.*, 2022); (Gao *et al.*, 2022); (Corbaz-Kurth *et al.*, 2022) ; (Brand *et al.*, 2022); (Sinniah *et al.*, 2022); (Aksay & Sendogdu, 2022); (Viana *et al.*, 2023); (Cheggag & Mokhlis, 2023); (Wulandhari *et al.*, 2023); (You *et al.*, 2023); (Suwandana *et al.*, 2023); (Kopp Leite *et al.*, 2023); (Mirtsch *et al.*, 2023); (Ferrón-Vílchez & Leyva-de la Hiz, 2023); (Bernal-Turnes *et al.*, 2023); (Peng, 2023); (Nguyen *et al.*, 2023); (Fu *et al.*, 2023); (Forliano *et al.*, 2023); (Zhao & Li, 2023); (Tarapituxwong *et al.*, 2023); (Shaya *et al.*, 2023); (Paeffgen, 2023); (Radovic-Markovic *et al.*, 2023); (Martín-Rojas *et al.*, 2023); (Wang, 2023); (Pescaroli, Velazquez *et al.*, 2023); (Tomej *et al.*, 2023); (Harsanto & Firmansyah, 2023); (Borms *et al.*, 2023); (Putritamara *et al.*, 2023); (AlMaian & Bu Qammaz, 2023); (Andrade *et al.*, 2023); (Zakaria *et al.*, 2023); (Valbuena *et al.*, 2023); (Shepherd & Williams, 2023); (Wided, 2023); (Yang *et al.*, 2023); (Zahari *et al.*, 2023); (Gan *et al.*, 2024); (Korpysa & Judit, 2024); (Fabiano *et al.*, 2024); (Haga & Ittonen, 2024); (Ewertowski & Kuzminski, 2024); (Prayag, Jiang, *et al.*, 2024); (Wang *et al.*, 2024); (Shafi & Middleton, 2024); (Park & Seo, 2024); (Haghighat *et al.*, 2024); (Romero-Lora *et al.*, 2024); (Lestari *et al.*, 2024); (Righi *et al.*, 2024); (Udod *et al.*, 2024); (Chytilová *et al.*, 2024)		
Assessment of organizational resilience	(Tillement *et al.*, 2009); (Arsovski *et al.*, 2015); (Ruiz-Martin *et al.*, 2015); (Kolay, 2016); (Patriarca *et al.*, 2018); (Tibay *et al.*, 2018); (Kativhu *et al.*, 2018); (Sanchis & Poler, 2019a); (Trijp *et al.*, 2019); (Al-Ayed, 2019); (Melián-Alzola *et al.*, 2020); (Soroka *et al.*, 2020); (Sweya *et al.*, 2020); (Williams *et al.*, 2020); (Ilseven & Puranam, 2021); (Chen *et al.*, 2021); (Santos & Spers, 2023); (Ignatowicz *et al.*, 2023); (Butkus, Rakauskiene *et al.*, 2023); (Ewertowski *et al.*, 2024); (Valau Soares & Soliman, 2024)	21	5
Concepts and attributes of enterprise resilience	(Erol *et al.*, 2010); (Braes & Brooks, 2011); (de Florio, 2013); (Sanchis & Poler, 2013); (Tadic & Aleksic, 2013); (Boin & van Eeten, 2013); (Winnard *et al.*, 2014); (Gilly *et al.*, 2014); (Tadić *et al.*, 2014); (Garrido, 2016); (De Galizia *et al.*, 2016); (Witmer & Mellinger, 2016); (Xiao & Cao, 2017); (Linnenluecke, 2017); (Ince *et al.*, 2017); (Ingram & Hunger, 2018); (Kahn *et al.*, 2018); (Koronis & Ponis, 2018); (Jafari *et al.*, 2018); (Barasa *et al.*, 2018); (Ruiz-Martin *et al.*, 2018); (Van Trijp *et al.*, 2018); (Schriber *et al.*, 2019); (Andersson *et al.*, 2019); (Witmer, 2019); (Ingram & Bratnicka-Mysliwiec, 2019); (Morales *et al.*, 2019); (Sanchis & Poler, 2019c); (Branco *et al.*, 2019); (Goldschmidt *et al.*, 2019); (Darkow, 2019); (Witmer, 2020); (Kim, 2020); (Cotta & Salvador, 2020); (Cruickshank, 2020); (Liu & Yin, 2020); (Sanchis, Canetta *et al.*, 2020); (Gečienė *et al.*, 2020); (Duchek *et al.*, 2020); (Duchek, 2020); (Hecklau *et al.*, 2021); (Saad *et al.*, 2021); (Ahmed *et al.*, 2021); (Fasey *et al.*, 2021); (Țiclău *et al.*, 2021); (Chen *et al.*, 2021); (Bento *et al.*, 2021); (Nowak, 2021); (Ojiangu *et al.*, 2021); (Hillmann & Guenther, 2021); (Thomas, 2021); (Börekçi *et al.*, 2021); (Gichuhi, 2021); (Liu *et al.*, 2021); (Potrich *et al.*, 2022); (Fasey *et al.*, 2022); (Abu Hasan *et al.*, 2022); (Istiqaroh *et al.*, 2022); (Ma *et al.*, 2022); (Lee *et al.*, 2022); (Limphaibool *et al.*, 2022); (Singh *et al.*, 2022); (Mondragón *et al.*, 2022); (Marquez-Tejon *et al.*, 2022) ; (Ruiz-Martin *et al.*, 2022); (Wright, 2022); (Hafeez *et al.*, 2022); (Abdullahi *et al.*, 2023); (Ostadi *et al.*, 2023); (Sánchez-García *et al.*, 2023);(Galaitsi *et al.*, 2023); (Hussain *et al.*, 2023); (Bostock & Breese, 2023); (Otola & Knop, 2023); (Sevilla *et al.*, 2023); (Dahmen, 2023); (Huber *et al.*, 2023); (Ciasullo *et al.*, 2024); (Mhlanga & Dzingirai, 2024); (Mehta *et al.*, 2024); (Florez-Jimenez *et al.*, 2024); (Khan *et al.*, 2024); (Rydzewski, 2024); (Reis Irigaray & Stocker, 2024)	84	19
Norms and standards related to enterprise resilience	(Zawada, 2011); (Żak, 2023)	2	0

Note: Appendix 1 contains the reference list of all texts included in Table 2.
Source: own study.

The data in Table 2 show that the largest number of the texts in the analysed collection represent the category of 'building a resilient enterprise' (29%). The categories of 'enterprise resilience in the face of global crises, pandemic and natural disasters' (24%) and 'concepts and attributes of enterprise

resilience' (19%) were in the second and third places, respectively. A smaller number of the texts represents the other scope categories.

Discussion of the Scope

The results of this scoping review bring a greater range of information and conclusions than other systematic or scoping reviews of the literature on enterprise resilience. Therefore, in comparison to previous reviews, such as Barasa *et al.*, 2018; Linnenluecke, 2017; Bento *et al.*, 2021, the results of the review presented in this text are new, innovative and much broader, mainly because of the range and number of the texts subjected to analysis and because of the restrictive scoping methodology adopted.

The keywords analysis conducted in this text, combined with the categorisation of the scope of the reviewed literature on enterprise resilience, first of all, allowed for the identification of the scope of the scientific literature published to date on the topic, and secondly led to the conclusion that addressing organizational resilience in scientific texts is determined by global events of disruptive change or crisis. This became apparent during the analysis of the substantive content of the texts conducted during the development of the scope. Figure 6 presents a timeline of the global events that determined the specific research themes of the scientific texts focused on enterprise resilience.

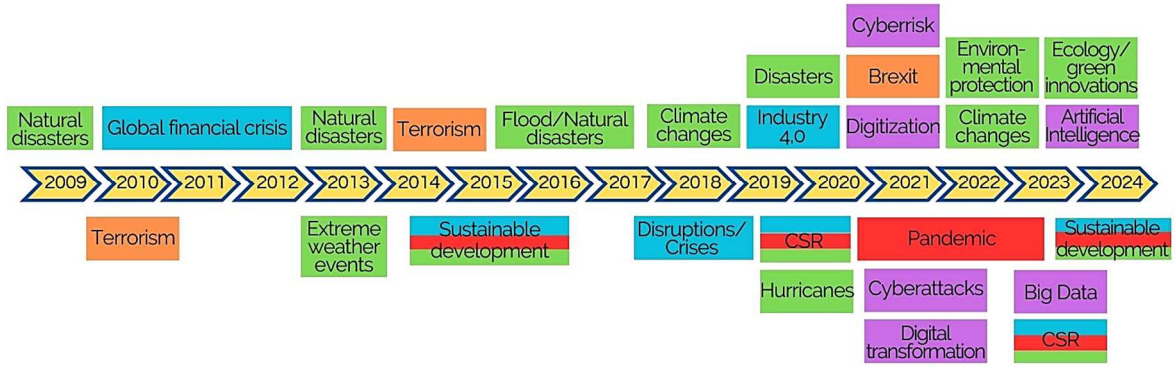

Figure 6. Global events determining the themes and intensity of publications on enterprise resilience
Note: colouring of global events: environmental – green, economic – blue, social – red, geopolitical – orange, technological – purple
Source: own elaboration.

CONCLUSIONS

The scoping review presented in this text on the issue of enterprise resilience allowed for the achievement of the established research objective and the provision of answers to the posed research questions. It was possible to determine the extent of the scientific literature on organizational resilience generated over the three decades from when the concept first appeared in the literature to the present.

The results of the analyses have several implications relevant to both theoretical considerations and practical applications of the concept of enterprise resilience. From a theoretical standpoint, an extensive scoping review, such as the one whose results are presented in this text, provides an excellent set of inputs for further research into enterprise resilience. Therefore, it is a specific determinant of the direction of further research in this area. This is because, above all, it makes it possible to identify what research has already been conducted (research issues, sectors covered, relations between resilience and other themes explored by management sciences) and which remaining research gaps need to be addressed on a priority basis. As far as practical applications are concerned, the results of this scoping review can serve as a compendium of knowledge for management practitioners who are at the stage of creating or strengthening resilience mechanisms and who need information on the best practices in this area. The conclusions from the review have practical applications for enterprises, mainly currently, in the conditions of high variability of the economic environment on a micro and

macro scale, in which these enterprises operate. They can therefore be helpful for managers responsible in enterprises directly or indirectly for risk management, crisis management or, ultimately, for building and strengthening resilience mechanisms in the face of potential crises.

The conducted research also had some limitations, but they were kept to a minimum due to the restrictive research methodology. Despite the inclusion of three databases of scientific texts in the analyses, there is some risk that there are other scientific texts that would meet the established inclusion criteria but were omitted due to their absence from the selected databases. Another limitation may be one of the criteria adopted for the inclusion of texts in the analyses, which was the availability of a text in the qualification of only texts available in an open-access format. However, the methodology of a reliable scoping review requires that besides titles or abstracts, the full texts of publications be analysed, so this criterion was obligatory for this research.

The performed analyses also shed clear light on directions for future research in the area of enterprise resilience. For example, they revealed a low percentage of texts on strategies supporting enterprise resilience, yet building and improving resilience strategies is one of the key challenges of modern businesses. The scoping review also indicated a low number of publications concerning the assessment of organizational resilience. This may be surprising since without methodical and up-to-date tools to measure resilience, it is not possible for enterprises to follow a path of continuous improvement in resilience to crises and events with the potential to become a crisis. Therefore, these topics should determine the direction of further research on enterprise resilience.

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Acknowledgements and Financial Disclosure

The article processing fee (APC) for too long articles (161 299 characters while the limit is 50 000 characters) has been paid by a grant from the Faculty of Management and Social Communication under the Strategic Programme Excellence Initiative at Jagiellonian University.

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International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.06

Managerial psychological gender and its impact on selected corporate behaviours

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ABSTRACT

Objective: The article aims to determine the psychological gender of leaders of the fastest-growing enterprises and its impact on corporate entrepreneurial behaviour and social responsibility.

Research Design & Methods: We conducted empirical, quantitative research on the leaders of companies from the top of the Forbes Diamonds List to obtain knowledge about their personality traits and behaviours that contribute to business success. Methods: survey research (n=150) applying Bem's BSRI gender role questionnaire, the concept of entrepreneurship orientation and the basic forms of corporate social responsibility (CSR). We also applied tests measuring the statistical significance of relationships between variables (Shapiro-Wilk, Ch2, V Kramer).

Findings: We identified three types of psychological gender culture among the leaders of the surveyed enterprises, the most numerous of which was mixed psychological culture. Androgynes (50 leaders) and unspecified cultures (46 leaders) constituted a total of 64% of the sample. With a few exceptions, there were no statistically significant differences in the entrepreneurial orientation, selected entrepreneurial behaviours, or involvement in responsible social activities of the identified gender cultures.

Implications & Recommendations: Women can and should perform managerial functions in business and achieve success, provided they acquire instrumental traits in the socialization process. The combination of instrumental and expressive traits in a person, especially in a manager, increases their adaptive intelligence and the probability of success regardless of biological sex. The postulate of gender diversity in top management is justified but in terms of psychological gender, not biological sex.

Contribution & Value Added: The research results show that the leaders of the fastest-growing companies have developed both instrumental and expressive features, which may indicate their high adaptive intelligence. Masculine culture differs from the others in a greater, statistically significant, feature: readiness for fierce competition and a lower declarative orientation towards climate protection, safe products, and concern for the local community in terms of social activity. The leaders' cultural, entrepreneurial, and social profiles have additional cognitive value. The results contribute to the development of the following areas: managerial competences, role congruity theory, the theory of higher echelons, and social/psychological gender in business.

Article type: research article

Keywords: androgyny; entrepreneurial orientation; social responsibility; AI; internationalization

JEL codes: M1, M5, M13, M14

Received: 26 September 2024 Revised: 22 April 2025 Accepted: 28 April 2025

Suggested citation:

Popczyk, W., Winnicka-Popczyk, A., & Jablonska, Z. (2025). Managerial psychological gender and its impact on selected corporate behaviours. *International Entrepreneurship Review,* 11(3), 133-159. https://doi.org/10.15678/IER.2025.1103.06

INTRODUCTION

In 2023, Professor Claudia Goldin from Harvard University received the Nobel Prize in Economic Sciences for her research on the situation of women in the labour market. She comprehensively examined the issue of women's earnings and their situation in the labour market over the centuries. Economic inequalities related to gender, shortage of women in managerial positions, gender segregation, and pay gap – these are common phenomena in the labour market, which are based on persistent social and cultural

stereotypes related to gender. The award for Claudia Goldin testifies to the problems' relevance and the need to solve them for economic, social, and moral reasons. The problem is difficult because it results from cultural conditions, which seem to be resistant to quick changes. The essence of the problem concerns historically and culturally shaped patterns of personality traits and behaviours of women and men, as well as persistent stereotypes regarding the expectations around managers' social roles. In addition to formal qualifications, knowledge and industry experience, a manager is expected to have agency, leadership, courage, vision, and readiness to take risks, which are features of an instrumental nature, biologically and then culturally identified with the male gender. It was believed that women, due to their biological conditions and then natural divisions of social roles and their perpetuation over time, are carriers of expressive features such as gentleness, sensitivity, empathy, caring, and community, which claim them to perform culturally specific functions other than men (Deaux & Lewis, 1984). Although a lot is changing and the number of women taking up managerial positions is increasing, the slogans 'think manager-think male' and 'think crisis-think female' are still present in organisational life and maintain stereotypes regarding the social role of a manager (Schein, 1973). Management literature of recent decades provides arguments that the modern business environment evolving towards unpredictability and discontinuity of changes requires a broader repertoire of adaptive behaviours from the manager, which involves the need to use the expressive features of others or develop and consolidate them in oneself. The former postulate can be implemented by ensuring gender diversity in top management teams (Hambrick, 2007). The presence of women on management boards is intended to provide a desirable combination of instrumental and expressive features of such teams, but, at the same time, it may cause undesirable gender conflicts (Ali *et al.*, 2023). The management literature poorly explores the concept of psychological/social gender culture (Bem, 1974; Mandal, 2000). It assumes that as a result of a cultural and moral revolution, a person may acquire, in the process of broadly understood socialization, personality traits characteristic of their biological sex and personality traits of the opposite sex, and become an androgyne with a combination of instrumental and expressive features, which allows them to have greater behavioural potential and free themselves from limitations related to biological gender as well as flexibly adapt to the situation. According to psychologists, this potential may significantly determine a person's professional successes and successful personal life. Although psychologists speak out much about androgyny and its advantages for human personality, we found only few studies on this topic in the field of management. We present them in the literature review. They mainly report the relationship between the psychological culture of a manager's gender and business effectiveness (Jurma & Powell, 1994; Srivastava & Nair, 2011; Powell *et al*., 2021). According to these studies, managers' androgynous personalities positively impact the results achieved by their enterprises and interpersonal relations in these organisations. However, in these few cases, the studies involved managers in companies with varying degrees of financial success, as well as lower-level managers. May and Spangenberg (1998) studied male MBA students and showed that those of them who had an androgynous personality presented a more flexible style of solving problems with the environment than the rest. Other studies (Lipinska-Grobelny & Wasiak, 2010) established a link between the gender culture of biological female managers and non-managers and their job satisfaction. In the latter case, only the percentage distribution of possible psychological cultures of women in managerial positions seems to be interesting from the point of view of the article's subject. These studies did not consider biological male managers and business financial results.

We aimed to determine the psychological gender of leaders of the fastest-growing enterprises in Poland as well as its impact on corporate entrepreneurial behaviour and social responsibility. Using the psychological concept, we wanted to solve the research problem of personality traits of leaders of the fastest-growing enterprises and their impact on selected corporate behaviours. This is the first study to identify the personality traits of highly successful managers in line with the need to search for new forms of managerial competences (Helfat & Martin, 2015). To solve this research problem, we formulated the following research questions:

RQ1: What psychological/social gender cultures are presented by the leaders of selected companies from the Forbes Diamonds List? Which culture dominates?

RQ2: How strong is the entrepreneurial orientation of the leaders of the selected enterprises?

RQ3: How strongly are the leaders of the selected enterprises involved in international expansion?

RQ4: What is the attitude of the leaders of the selected enterprises towards artificial intelligence?

RQ5: What is the social responsibility profile of the leaders of the selected enterprises like?

RQ6: Is there a relationship between the psychological gender culture of the leaders and their entrepreneurial orientation, commitment to international expansion, and attitude towards artificial intelligence?

RQ7: Is there a relationship between the leaders' psychological gender culture and their social responsibility?

RQ8: Is there a relationship between the leaders' entrepreneurial orientation and their social responsibility?

By solving the research problem and learning about the personality traits of biological women who are leaders, it will be possible to refer to the conditions that enable them to fulfil the demanding role of a manager.

The research used a quantitative method on a sample of n=150 leaders of companies occupying top positions on the Forbes Diamonds List in 2022.

LITERATURE REVIEW

To review the literature, we used Sage Publishing and Google Scholars databases, formulating the search phrases as: social role of gender, social/psychological gender culture in management/business, androgyny in business. We explored the 'relevance' and 'the latest' filters. Based on the analysis of abstracts, from over 5 000 items, we selected 100 of them. The vast majority of the rejected publications concerned the issue of biological sex in managerial positions, the role of biological women in organisations, patriarchal structures, and succession strategies in family businesses. The appearance of such entries in the search engine is related to the fact that in the management literature, the terms 'gender' and 'sex' are commonly used interchangeably, which from the point of view of psychology have different meanings. We divided the selected literature into three thematic threads: the role congruence theory, gender diversity in management from the perspective of higher echelons, and the concept of psychological gender and conducted the review.

The Social Role/Role-congruence Theory

Gender stereotypes have their origins in the division of labour based on gender cultural patterns, according to which the means of production are controlled by men within a patriarchal social structure. The socialization of people within this structure perpetuates stereotypes (Ruble *et al.*, 2006). It is not the individual but the culture that is responsible for creating gender stereotypes (Fiske & Taylor, 2013; Hinton, 2016). The social role theory/role congruence theory (Eagly, 1987, 1995, 1997; Skelly & Johnson, 2011; Koenig & Eagly, 2014; Koch *et al*., 2015; Ellemers, 2018; Triana *et al.,* 2024) explains the gender stereotypes present when employing women in managerial positions as the result of historically shaped social roles of women and men. Candidates for managerial positions are expected to have technical knowledge, cognitive intelligence and culturally as well as biologically desirable features associated with the male gender, such as leadership predispositions, readiness for aggressive competition, strength, agency, assertiveness, and success orientation. Women are biologically and culturally assigned with caring characteristics, caring for family and home, gentleness, community, and orientation towards social relationships. In business, they are perceived as risk-averse (Maxfield *et al.,* 2010). Employers may assess these features as not fitting the expectations related to the manager's role and therefore disqualifying women applying for professional promotion. In turn, women who are active leaders and manifest masculine characteristics acquired through socialization are accused of violating gender cultural standards by conservatives (Eagly & Karau, 2002). Maintaining gender stereotypes may result from a male threat to self-esteem (Owuamalam & Zagefka, 2014; Inesi & Cable, 2015; Williams

& Tiedens, 2016). The theory of psycho-dynamic systems (Padavic *et al.,* 2020) explains women's difficult access to professional advancement in organisations with work-family conflict. Women are unable to increase their commitment to work and work longer hours due to their household responsibilities resulting from the cultural gender role pattern.

The Perspective of Higher Echelons and Gender Diversity in Management

According to the theory, managerial competences shape the dominant logic in an enterprise, which determines the routine, procedures and skills influencing the implementation of adopted strategies and the search for new growth and development options (Kor & Mesko, 2013). Enterprises are a reflection of their leaders, and their knowledge, experience, values and behaviours translate into decisions and assessments of the organisational situation (Cannella & Monroe, 1997). Despite progress in research on the impact of managerial competences on the results of enterprises and their competitive positions, there is a need for further research and deepening the knowledge about this relationship (Helfat & Martin, 2015). It is suggested that researchers use the theory of higher echelons (Carpenter *et al.,* 2004; Hambrick, 2007) as a construct for designing research determining how various characteristics of the top management team, such as the size and demographic characteristics of its members, affect the team's effectiveness and the company's results. A company's strategic behaviour reflects the team's collective leadership, team knowledge, skills, and interactions. The literature on optimizing the composition of the top management team includes publications indicating that diversifying its composition in terms of gender has a positive impact on its effectiveness and the company's results. Women enrich the team's managerial skills, and decision-making processes, and positively influence the innovative activity of the company (Bagshaw, 2004; Torchia *et al*., 2011; Diaz-Garcia *et al*., 2013). Women as managers, unlike men, are more people – and employee-oriented, more democratic, ready for cooperation and support, with greater inclinations to build interpersonal relationships (Brown *et al.,* 2002). Managerial competencies combine technical, conceptual, and social skills (Katz, 1974) and are necessary for the effective creation, integration and reconfiguration of enterprise resources (Adner & Helfat, 2003). The sources of technical, conceptual and social skills of managers are knowledge, education, experience, values and personality traits that have instrumental and expressive dimensions. Deaux and Lewis (1984) used the above-mentioned dimensions of personality traits. Instrumental features are characteristic of the socially, culturally shaped, traditional male gender schema, while expressive features are characteristic of the culturally shaped female gender schema. Instrumental features in the masculine schema include, among others: leadership tendencies, agency, self-confidence, aggression, ambition (need for success), egoism, assertiveness (Bem, 1974) and those that mostly constitute the entrepreneurial orientation: innovativeness, proactivity, lack of risk aversion, autonomy, readiness for fierce competition (Lumpkin & Dess, 1996). There is no consensus in the literature on treating innovation in the entrepreneurial orientation as a purely instrumental feature. It is believed that women have an advantage over men in generating ideas and social competences, which makes them more innovative and conducive to knowledge creation (Hisrich & Brush, 1984; Sandberg, 2013). The feminine schema (expressive features) includes, among others: gentleness, empathy, understanding, compliance, and community. Deductively, the source of the benefits of a gender-diversified top management team is the combination of not only knowledge and experience but also instrumental and expressive features that allow for flexibility and adaptability of managerial behaviours.

Previous empirical research confirms that gender diversity in management teams provides diverse types of skills, knowledge and ideas that translate into benefits for the organisation (Krishnan & Park, 2005; Ruigrok *et al.,* 2007; Torchia *et al.,* 2011). It is associated with better problem-solving, greater innovation, learning, flexibility of activities, and diversity of competences (Ostergaard *et al.,* 2011). Miller and Triana (2009) and Kaymakam (2023) suggest that gender diversity in management teams provides diverse human and social capital that helps the teams create new ideas, appropriately allocate resources, and discover opportunities in R&D activities. It allows for the creation of an open work environment (Nielsen & Huse, 2010). Most empirical research on the positive impact of gender diversity in top management teams focuses on the financial performance of large companies (Smith *et al.,* 2006; Jurkus *et al.,* 2011; Dezso & Ross, 2011; Joecks *et al.,* 2013). There are known results of research

on this relationship in other contexts. In their research conducted among Spanish small and medium-sized technology enterprises (culturally masculine sectors), Ruiz-Jimenez and del Mar Fuentes-Fuentes (2016) showed that the gender diversity of top management teams increases (moderates) the positive impact of managerial competences on product and process innovations of enterprises.

Few studies in the literature indicate a negative relationship between gender diversification in management teams and corporate performance (Dwyer *et al*., 2003; Ali *et al.,* 2015) or an insignificant relationship between them (Moscu, 2013; Richard *et al.*, 2013). Subsequent studies have found that this relationship may be non-linear, *i.e.*, it is positive or negative depending on the level of gender diversification and the type of sector, *e.g.*, men's or women's (Nakagawa & Schreiber, 2014; Schwab *et al*., 2016; Adusei *et al.,* 2017; Bae & Skaggs, 2019; Ali *et al.,* 2023). In these cases, the form of the relationship between the level of gender diversification and labour productivity has the shape of a U-chart (Bae & Skaggs, 2019; Ali *et al.,* 2023) and between gender diversification and financial performance and market value has the shape of an inverted U-chart (Nakagawa & Schreiber, 2014; Adusei *et al.*, 2017). Richard *et al.* (2013) suggest that the type of graph (U-shaped and inverted U-shaped) of the relationship between gender diversification and labour productivity depends on the risk taken in the enterprise/sector. The benefits of gender diversification for labour productivity resulting from the combination of knowledge, skills, and instrumental and expressive features may turn out to be smaller than the potential problems caused by gender conflicts in management teams in the case of a low level of gender diversity in male sectors (Chart U) or too high level in women's sectors (inverted U-plot) (Ali *et al.,* 2023).

Gender diversity in management teams has a positive impact on corporate social responsibility (Liao *et al.*, 2015; Seto-Pamies, 2015; Rao & Tilt, 2016; Terjesen *et al.,* 2016; Francoeur *et al.,* 2019; Katmon *et al.,* 2019; Peng *et al.,* 2021, 2022). In such teams, compared to men, women have greater social sensitivity, a stronger orientation towards building long-term social relationships and more ethical behaviour (Czyzewska, 2006; Terjesen *et al.,* 2016), which means that thanks to gender diversity, enterprises will defend the weakest stakeholders. Only two literature sources claim that the relationship between the gender diversity of the board and the company's CSR activity is statistically insignificant (Bear *et al.,* 2010; Boulouta, 2013). Peng *et al.* (2022) explain these two cases with factors that may negatively moderate the relationship in question. In their empirical research, they showed that national culture, and specifically its dimension of masculinism, plays such a role (Hofstede *et al.,* 2010). We think that the size of the company may also be such a moderator. One of the development barriers of small and medium-sized enterprises is resource scarcity, and therefore their intentions towards sustainable development may remain in the declarative sphere due to the priority of growth and development of the enterprise and the mobilization of financial resources for these purposes.

The Concept of Psychological/Cultural Gender in Management

Although every person has two elements within themselves: male and female ones (Bem, 1974; 1997), their gender is biologically categorized at the moment of birth. In the past, there was a belief in a strong connection between a person's biological sex and their psychological characteristics and behaviours (Constantinople, 1973). The so-called *biological position* assumes that the psychological differences between biological sexes are the result of differences in the production of sex hormones (Zuckerman, 1991). Testosterone – the male hormone – is responsible for aggression and its derivatives, *i.e.*, self-confidence, the tendency to dominate and compete. Prolactin – a female hormone – determines caring behaviour, sensitivity, and tenderness. In turn, the structural and functional differences of the female and male brain are the source of expressive features and the socio-emotional nature of female activities as well as instrumental features and the cognitive nature of male activities (Moir & Jessel, 1992). Moreover, sociobiologists add that differences in the personality of women and men have been consolidated in the course of evolutionary processes as a result of the specialization of social roles and the division of labour between them (Buss, 2019). The cultural approach presents a different position. During the socialization process, differences between cultural gender patterns, *i.e.*, between femininity and masculinity, formed and consolidated (Eagly, 1987; Lott & Maluso, 1993). Because the socio-cultural environment changes over time, the socialisation conditions also change, which means that,

in addition to innate sex characteristics, other features that determine behaviour regardless of biological sex may be acquired. Women may acquire various masculine (instrumental) traits to varying degrees, in turn, men may acquire various feminine (expressive) traits. On this basis, scholars introduced a new notion of psychological /cultural gender as a person's ability to categorize and perceive themselves in cultural patterns of femininity and masculinity (Mandal, 2000), which translates into behaviour and attitudes independent of biological sex. Bem (1974, 1997) distinguished the cultural female gender, the cultural male gender and the mixed gender culture – characteristics of individuals who have developed the traits of the opposite biological sex. In the course of further research she defined four types of cultural/psychological gender: culturally defined people whose psychological features are characteristic of their biological sex, culturally undefined people whose neither female nor male features are not shaped distinctly, independently of biological sex, androgynous people who are characterized by clear, strong both feminine and masculine features regardless of biological sex and finally, there are cross-cultural persons, largely defined by the psychological features of the opposite biological sex. In addition to the individuals culturally defined according to their biological sexes (masculine men, feminine women), the rest have mixed gender. People of mixed gender have a potentially greater repertoire of behaviours and adaptability in specific life and professional situations. Among them, androgynous people have the widest potential for possible behaviours and the greatest opportunities for constructive action. Empirical research (Klimicka *et al.,* 1987; Faulkender, 1991) shows the potentially positive relationship between androgyny and satisfying the needs of human self-actualization. Having only clearly developed cultural characteristics consistent with biological sex is not always beneficial (Bem, 1997). A high femininity index in women is often associated with a high level of anxiety, low self-esteem and low social acceptance, and in turn, a high masculinity index in men causes a high level of anxiety, high neuroticism, and low self-acceptance. According to Bem (1997), young people with a clear gender identity may have lower cognitive abilities, lower spatial imagination and lower creative abilities. Androgynous personalities can add particular value in the following professional activities: medicine (Rupavataram, 2017), art (Jonsson & Carlsson, 2000), science (Norlander *et al.,* 2000), and leadership (Kark *et al.,* 2012; Way & Marques, 2013; Powell & Butterfield, 2015).

Despite recognizing the value and importance of a wide range of instrumental and expressive features in a human personality for the quality of their life, representatives of psychology in the twenty-first century have a critical approach to traditional androgyny because they consider it unnatural for a person to have a biological sex and a psychological sex, *i.e.*, they question the possible dualism in this respect, which may cause internal disharmony, personality, and cultural conflicts (Woodhill & Samuels, 2023). In their opinion, a person has one biological sex, with which they are born and which determines their behaviours only within a physiological and socially limited scope. An individual's basic social behaviours result from personality traits acquired in the socialization process and predispose them to fulfil the same social roles regardless of biological sex. Therefore, they propose a new model of social androgyny called neoandrogyny, devoid of references to biological sex and its limitations. In the socialization process, neoandrogynes acquire a combination of instrumental, expressive and neutral features, which determine positive social androgyny with the following parameters: a sense of fulfilment, social respect, high self-esteem, acceptance of others, internal locus of control. In turn, the factors supporting the intensity of positive androgyny are social effectiveness (emotional intelligence), creativity, abilities (talents, passions), outstandingness (exceptionality, excellence, charisma) and determination (enthusiasm, commitment, optimism). Therefore, modern androgyny refers to the theory of adaptive intelligence (Sternberg, 2020), reminiscent of multiple intelligence (Gardner, 2011). It is a specific combination of social intelligence with cognitive, analytical, and creative skills, allowing an individual to set and achieve significant goals in life in the context of a specific culture (Sternberg, 2020).

In light of the above, mixed gender culture, especially androgyny, should be the subject of interest in management sciences in the context of the desired personality traits of managers and their behavioural potential as well as the ability to adapt to various circumstances. However, there is little discussion on this topic in the management literature. Androgyny causes flexibility in human behaviour depending on the situation (Bem, 1975) and increases leadership effectiveness (Hall *et al.,* 1998). Sargent (1979) believes that the androgynous personality in a managerial position, combining instrumental

and expressive features and using them in a wide repertoire of behaviours, is highly desirable. In her opinion, women should become more assertive, self-confident and ready to exercise power, while men, in turn, should be more cooperation-oriented, less competitive, more open and supportive of others. May and Spangenberg (1998) studied male MBA students preparing to perform managerial roles and showed that those of them who had an androgynous personality presented a more flexible style of solving problems with the environment than others. The results of research by Jurma and Powell (1994) and Lay (1994) showed that subordinates in organisations are more satisfied when their superiors have culturally assigned characteristics, both feminine and masculine. Respondents rated the androgynous managers the highest, and managers with a dominance of feminine characteristics as more effective than those with a dominance of masculine characteristics. Based on the gender role questionnaire (BSRI) by Bem (1974), Srivastava and Nair (2011) showed that in a sample of 300 middle and lower-level managers of female and male biological sex, employed in various sectors, there were three gender cultures: feminine, masculine, and androgynous. The androgynous culture included people with strong both feminine and masculine features as well as those presenting both feminine and masculine features but with less intensity, referred to in the literature as people without a gender-cultural identity. From the point of view of management sciences, it seemed right to treat both subgroups together as individuals with a mixed gender culture, demonstrating a wide repertoire of behaviours and adaptive skills thanks to having both instrumental and expressive features. The research detected a positive and statistically significant relationship between androgyny (broadly understood as mixed-gender culture) and managerial effectiveness measured by the MEQ test by Gupta (1996). During research on the relationship between job satisfaction and gender culture of women in managerial and non-managerial positions in Poland, Lipinska-Grobelny and Wasiak (2010) found that regardless of the position held, the largest percentage was androgynous personalities – approximately 49%, and the smallest for the female gender – 15% in the case of managers and 1.6% for the male gender among women holding other positions. The second place among women managers was taken by the male gender – 20%, and among non-managers, the female gender – 35.5%. The results indicate that women managers from a male culture experience the highest remuneration satisfaction, while those from a typically feminine culture experience the least satisfaction from remuneration. Recent research on a large sample has found that the most effective managers show a decreasing emphasis on masculinity and an increasing emphasis on femininity over time (Powell *et al.,* 2021). The authors of the study claim that an effective, efficient manager is one with an androgynous personality.

Due to the limited quantity and scope of empirical research on this topic conducted so far worldwide, the authors studying the topic do not formulate research hypotheses. They focus on finding answers to the research questions posed above. To date, the existing research reports prove only that there is a positive correlation between the personality of managers presenting a mixed psychological gender culture and the results achieved by the companies or divisions they manage (Jurma & Powell, 1994; Srivastava & Nair, 2011; Powell *et al*., 2021). There is no research that would determine the psychological gender cultures of top managers of strategically and economically unique companies and characterise their cultural, entrepreneurial, and social profiles.

RESEARCH METHODOLOGY

Justification for the Selection of Research Subjects

According to the art of strategic management, the continuous development and growth of an enterprise are crucial for its competitive position and long-term functioning. Those enterprises that grow faster, increase their market shares, better adapt to changes in the environment, and increase their competitive advantage over their rivals. Strategic management is the domain of the leader, and the top management team, and the strategic goals achieved are a function of their competences, including their personality traits, values, and behaviours. The literature review indicates that the combination of instrumental and expressive personality traits of people who make decisions and shape the logic and strategic culture of the enterprise they manage is of great importance for managerial success. To achieve the optimal combination of these features, organisations should introduce gender diversity

into the management team. Men typically display instrumental traits, in line with traditional gender cultural patterns. Women, on the other hand, tend to embody expressive traits. Alternatively, organizations can select candidates for managerial positions who possess a mixed gender culture. These individuals demonstrate both instrumental and expressive traits, which enables them to behave flexibly and adapt their actions according to changing conditions and needs. The latter solution, little explored in scientific research and in the literature, may seem particularly interesting for micro, small, and medium-sized enterprises that cannot afford extensive management teams and gender diversity due to resource barriers. In turn, large companies should strive for gender diversity on management boards, but in a cultural and not a purely biological context. Therefore, we decided to conduct empirical, quantitative research on the leaders of companies with the strongest growth orientation from the Forbes Diamonds List 2022 in Poland. Our goal was to gain insights into the personality traits that contribute to their undeniable business success. These traits may serve as a source of reflection for other business practitioners and for decision-makers responsible for shaping broadly understood education.

Research Design

Using the quantitative method, *i.e.,* survey research, we collected empirical material to solve the research problem and achieve the goal. We conducted the survey research using the CATI technique in the period November-December 2023.

In total, n=150 companies from the 2022 Forbes Diamonds List participated in the survey. We intended to research the leaders of companies occupying the top positions on the list. Initially, we assumed a limit of the first 2 000 companies (11 818 total quotes) with relatively comparable significant strategic achievements. The selection of the sample consisted of telephone contacts, starting with the leader of the list and ending finally at the company ranked in 2016, asking their leaders / key decision-makers to participate in the survey. In total, 150 of them agreed and we received 150 complete questionnaires. This approach provided an opportunity to select the best companies with relatively comparable achievements. Namely, to be included on the list, companies must have a positive credibility rating and sales revenues in the last year of not less than PLN 5 million. For this purpose, we assessed the following candidate indicators: EBIT, ROA, financial liquidity, timely payment of receivables, financial results, and revenues. Then, we valued companies using the Swiss method, which combines asset and income valuations, because entities focused on growth and investments may not show high profits. The integration of both approaches offers a more comprehensive picture of the company's value, which ultimately determines its place in the ranking. This value is averaged over the last five years and updated annually. The research sample constituted 7.5% of the subgroup of the 2016 fastest-growing companies from the List.

The questionnaire applied consisted of five parts. We used the first part to obtain the values of control variables: biological sex of the leader, place of birth, marital status, education, age of the enterprise, its size, regional location, organisational and legal form, family/non-family nature. The second part of the questionnaire, based on the classic, traditional (used in other studies around the world) BSRI Gender Role Questionnaire (Bem, 1974), allowed for the measurement of the leader's gender culture. Traditional gender culture patterns: female and male reflect a precise division into expressive and instrumental features, which is important in the managerial context. Our questionnaire included additional features related to the perception of femininity (family-oriented, timidity, obedience, need to feel safe, forgiveness) and masculinity (bravado, excitability, pride, sensitivity to honour, weakness for alcohol) in Polish culture (Zukowska, 2006). In total, on a scale of 1-5, the leaders determined the intensity of 26 feminine (expressive) and 26 masculine (instrumental) traits. The third part of the questionnaire measured the leader's entrepreneurial orientation on a scale of 1-5, using five features considered to be the definition of entrepreneurial orientation (Lumpkin & Dess, 1996): innovation, proactivity, risk tolerance, sense of autonomy, and readiness to compete. We gave respondents a detailed interpretation of proactivity. The next part of the questionnaire measured two selected entrepreneurial behaviours of the selected companies: commitment to international expansion and attitude towards artificial intelligence. The last part of the questionnaire intended to help determine the level (scale 1-5) of social responsibility of the surveyed leaders and the activity of the enterprises they manage in this area.

Although the questionnaire consists of parts that are scientific constructs deeply rooted in scientific theory and research (BSRI by Bem, entrepreneurial orientation by Lumpkin & Dess, CSR), we conducted a pilot study on a sample of 25 leaders of enterprises from the Forbes Diamond List in September 2023 to check the internal consistency of the survey construct used in this study and estimate its reliability. We did it using Cronbach's Alpha reliability coefficient. We also examined how removing individual questions would affect the change in the value of this indicator. We performed such analyses separately for each of the question sections: masculine aspects (26 questions), feminine aspects (26 questions), and entrepreneurial aspects (5 questions). For each of these sections, the Cronbach's alpha coefficient value was more than 0.7, which means that the respondents provided consistent answers. The section of the questions about feminine aspects was characterized by the greatest consistency (0.922 with a 95% confidence interval of 0.84 to 0.956). None of the survey questions significantly improved the questionnaire's reliability, so we may consider its composition appropriately selected (Cronbach, 1951).

RESULTS AND DISCUSSION

Demographics of the Surveyed Leaders

The vast majority of the respondents were biological men – 95 of them. The number of biological women participating in the study was 55. The largest group of respondents were people who got married. In total, 107 out of 150 respondents chose this answer. Moreover, 29 surveyed leaders were single, while another 14 respondents lived in extramarital relationships. The largest number of the leaders participating in the survey (129) had higher education, 17 respondents had secondary education, and the remaining 4 had vocational education. The respondents most often represented companies run in the form of a limited liability company – there were 119 of them, 13 respondents indicated that they represented a general partnership, 9 a joint-stock company, 4 a limited partnership, 2 respondents ran businesses as natural persons, the rest of the respondents indicated other organisational and legal forms. Half of the respondents (75 people) answered that they represented a family business. Furthermore, 82 leaders managed a small enterprise, 38 a medium-sized enterprise, 21 a micro-enterprise, and 9 a large enterprise (the questionnaire included the criteria of the European typology of companies).

A Method for Identifying the Psychological Gender Culture of Leaders of the Surveyed Enterprises

To determine what type of psychological/social gender culture the surveyed representatives of companies on the Forbes Diamonds List represent, the survey questionnaire included a segment in which we asked the respondents to rate 52 features in terms of the degree to which the features occurred in them. The respondents used a 5-point scale, where 1 meant that a given feature did not occur at all in the respondent, and 5 meant that it occurred very strongly. We treated the first 26 features listed in the survey questionnaire as masculine – instrumental features, and the next 26 features as feminine – expressive features. For each respondent participating in the study, we calculated the sums of points in the male and female parts. In the next step, we calculated the difference between these two sums (sum of points in the male part minus the sum of points in the female part). We graphically analysed the distribution of results using a histogram and a quantile chart (Figure 1). As expected, the distribution of differences was close to normal ($p>0.05$; Shapiro-Wilk test). The mean of the differences was -14 points and the standard deviation was 14 points. Parametric statistical tests may be used when the variables are normally distributed. Developing a method for identifying the psychological gender culture of leaders required consultations with professional statisticians.

With this in mind, we adopted the following division:

1. If the difference was within one standard deviation from the mean, i.e., -28 to 0 points, we then qualified the respondent as representing a mixed social gender culture,
2. for results below one standard deviation from the mean value, i.e., less than 28 points, we classified a given respondent as a representative of a female social culture,
3. If the result was higher than 0 points, then we classified the respondent as a representative of a male social culture.

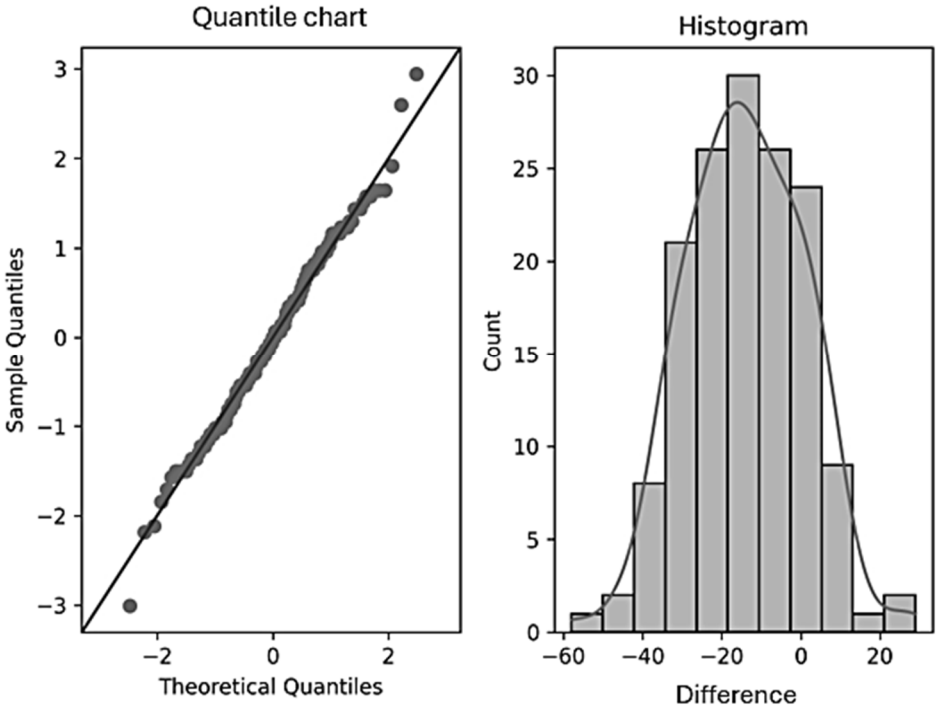

Figure 1. Distribution of the obtained test results (n=150)
Source: own elaboration.

Gender Cultures of the Surveyed Leaders

Adopting the described methodological assumptions regarding the method of determining the social gender culture of the respondents, we established that out of 150 respondents participating in the study, 96 of them represented the mixed type of social gender culture, 28 people represented female gender culture and 26 people represented male gender culture, *i.e.*, 64%, 19%, and approx. 17% respectively. Most leaders have developed both instrumental and expressive qualities. These are individuals with androgynous traits and ones with an undefined psychological culture. The research results also allowed us to determine what percentage of biological men and women participating in the study we could describe as representatives of mixed, male and female social gender cultures. Table 1 presents the results.

Table 1. The biological sex of respondents and their psychological gender culture (n=150) in percentage

Features	Male psychological culture	Mixed psychological culture	Female psychological culture	Total
Female biological sex	12.8	54.5	32.7	100%
Male biological sex	20.0	69.5	10.5	100%

Phi < 0.03, V Kramera 0.277.
Source: own study.

The results show that we can identify 30 biological women and 66 biological men participating in the study based on their responses to the survey questionnaire as representatives of the mixed psychological gender culture. We classified 7 biological women and 19 biological men into the male gender culture. In turn, we considered 18 biological women and 10 biological men to exhibit characteristics of the female psychological culture.

Entrepreneurial Orientation of the Leaders, Selected Corporate Activities, and their Relationships with Gender Culture

Another research goal was to determine the entrepreneurial orientation of the surveyed company leaders. To be able to make such a determination, the survey questionnaire included a question in

which we asked respondents to indicate which of the following five features: innovativeness, proactivity (ability to identify opportunities and threats), risk tolerance, readiness to compete in the sector, autonomy they find in themselves and to what extent. The respondents answering this question were to rate the intensity of each of these five features in themselves using a 5-point scale, where 1 meant that the respondent did not identify a given feature in themselves, and 5 meant that they identified it to a very large extent. Figure 2 presents the results of the respondents' answers to this question.

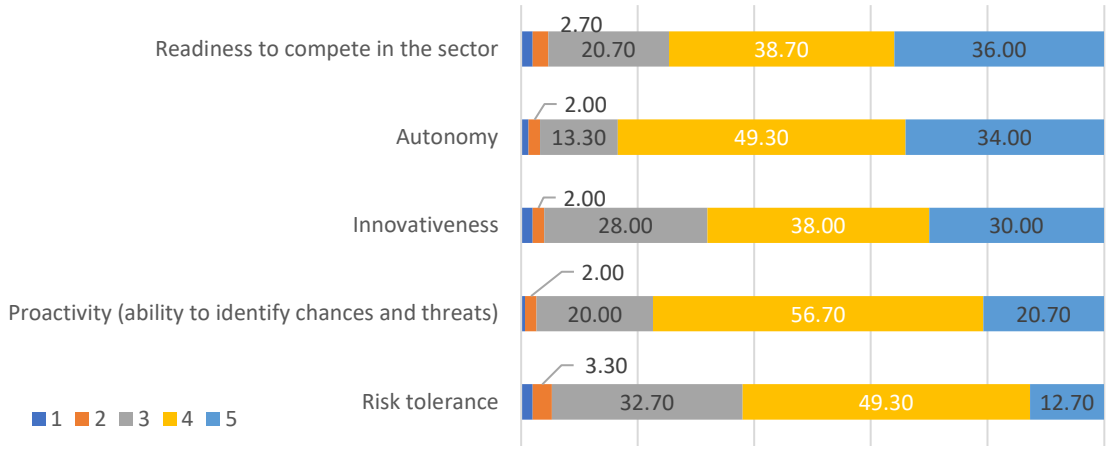

Figure 2. Entrepreneurial orientation of surveyed leaders (n=150) in percentage
Source: own elaboration.

The research results provide the basis for stating that the respondents have a relatively strong entrepreneurial orientation. For each of the assessed features, the cumulative percentage of ratings '4' and '5' was not lower than 60.0%. In the case of the innovativeness feature, it was exactly 68.0%, in the case of proactiveness: 77.4%, risk tolerance – 62.0%, the readiness to compete in the sector – 74.7%, and autonomy – 83.3%. Noteworthy, 60 out of 150 respondents marked '4' and/or '5' in relation to all 5 examined features. The entrepreneurial orientation of the surveyed respondents, in the light of the research results, is characterized primarily by a high degree of internal autonomy, proactivity and readiness to fight in a competitive sector. Respondents most often rated these features as '4' and '5'. The presented results indicate the source of the success of companies from the Forbes Diamonds List. Thanks to the strong entrepreneurial orientation of their leaders, they grow quickly and build sustainable competitive advantage.

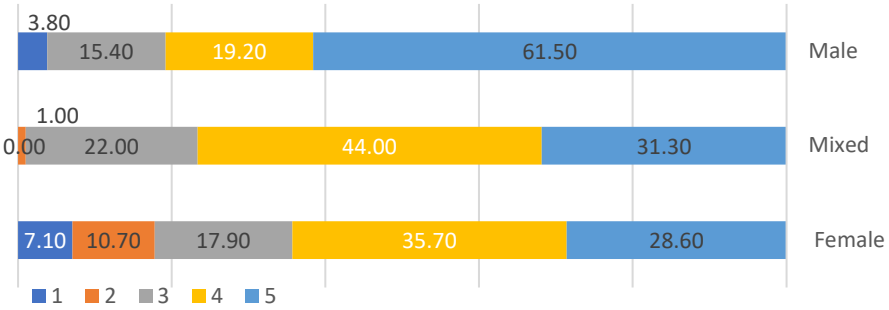

Figure 3. Readiness to compete in the sector and social culture of gender (n=150) in percentage
Source: own elaboration.

The results of the conducted research showed that people assigned to the male psychological culture were statistically significantly more likely to choose higher scores measuring the feature of readiness to compete in the sector than the respondents assigned to the other types of psychological gender culture (ch2 = 24.47914916, p-value = 0.00259948). In the remaining cases of the dimensions of entrepreneurial orientation, the type of psychological/social gender culture was not a variable that would statistically significantly differentiate the respondents' assessments ($p>0.05$).

We may explain this only difference by the presence of the male hormone testosterone responsible for developing instrumental traits: aggression, and its derivatives, *i.e.*, self-confidence and the tendency to dominate and compete (Zuckerman, 1991).

Moreover, when analysing the research results, we did not detect any statistically significant relationship between the socio-demographic characteristics of the respondents, the status of their businesses (family/non-family), and their entrepreneurial orientation ($p>0.05$).

More than half of the surveyed leaders, *i.e.*, 78 people, declared that their companies were expanding on international markets. Another 21 people declared that they planned to do so in the future. Moreover, 51 survey participants indicated that their companies did not conduct international expansion and did not plan it. Only 18% (27 enterprises) generated significant revenues from sales on foreign markets (intensity rated 4 or 5). The average assessment of the intensity of international activity given by the respondents was 2.14, which allowed us to conclude that the overall level of expansion on foreign markets of the surveyed enterprises remains surprisingly low. There was no statistically significant relationship between international expansion, its intensity and their leader's psychological gender ($p>0.05$).

The questionnaire included a question determining the attitude of the surveyed leaders to the use of artificial intelligence in enterprises they manage. This question was closed-ended. Its cafeteria consisted of three answers: positive, negative, and neutral. Out of 150 respondents, 72 of them (almost half) described their attitude to the use of artificial intelligence in business as positive. Another 65 respondents indicated that their view in this area was neutral. The smallest group (13 leaders) of the respondents described their attitude towards the use of artificial intelligence in business as negative. The socio-demographic characteristics of the respondents, the type of their gender culture or the type of company (family/non-family) did not have statistical significance for their answers to this question ($p>0.05$).

The Profile of Social Responsibility of the Leaders of the Surveyed Enterprises and its Relationship With Gender Culture

The first question on this topic asked whether the respondent believed that corporate social responsibility was necessary. The question was single-choice. When answering this question, the surveyed leaders used a 5-point scale, where 1 meant that corporate social responsibility is definitely not necessary, and 5 that it is definitely necessary. Figure 4 presents the results of the responses.

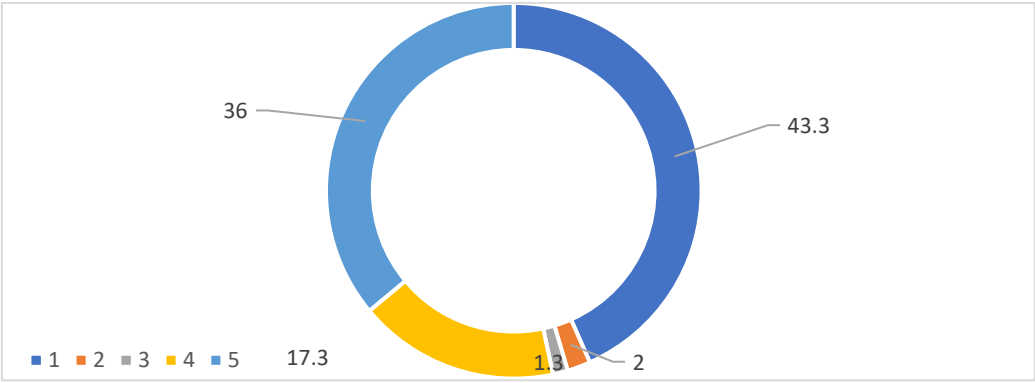

Figure 4. Is corporate social responsibility necessary? (n=150) in percentage
Source: own elaboration.

Of the 150 survey participants, the largest group were those who strongly shared the view that corporate social responsibility is necessary. In total, 65 respondents marked the highest rating, *i.e.*, 5 and 54 respondents pointed to the rating '4'. Therefore, a total of 119 out of 150 survey participants shared the view on the need for corporate social responsibility to a large or very large extent. Moreover, 26 respondents marked the rating 3 – indicating that they share this view to an average extent. Only two respondents gave the rating '2' and three respondents gave the rating '1'. The average of all ratings given by the respondents was 4.17, which may be additional confirmation that the group of surveyed business leaders is dominated by the view of the need to demonstrate corporate social responsibility.

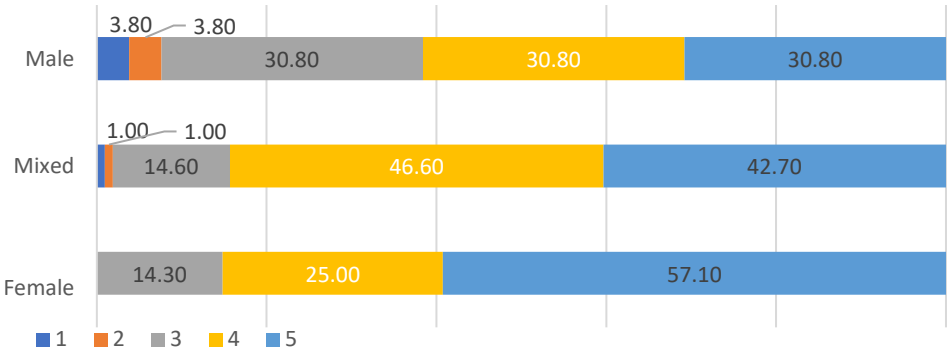

Figure 5. Social gender and the assessment of the need to demonstrate corporate social responsibility (n=150) in percentage
Source: own elaboration.

The research showed that more than half of the respondents assigned to male, female, and mixed genders believe that corporate social responsibility is very or very much necessary. In the case of respondents representing mixed and female gender cultures, over 80% of respondents assigned to these two groups gave the ratings '4' and '5'. However, the chi-square test did not show a statistically significant correlation between social gender culture and the assessment of the need for corporate social responsibility (ch2 = 10.06938574, p-value = 0.24955009). This finding is surprising because it was believed that leaders with developed expressive traits would be much more oriented towards social activities than representatives of the masculine culture.

In the next question of the survey, we asked the participants to indicate in which areas, in their opinion, corporate social responsibility should be manifested. The question was semi-open. Its cafeteria included five proposed answer options, in addition, the respondents could choose a different answer and indicate their proposals for areas in which business should be socially responsible. The question was multiple choice; respondents could indicate any number of answers.

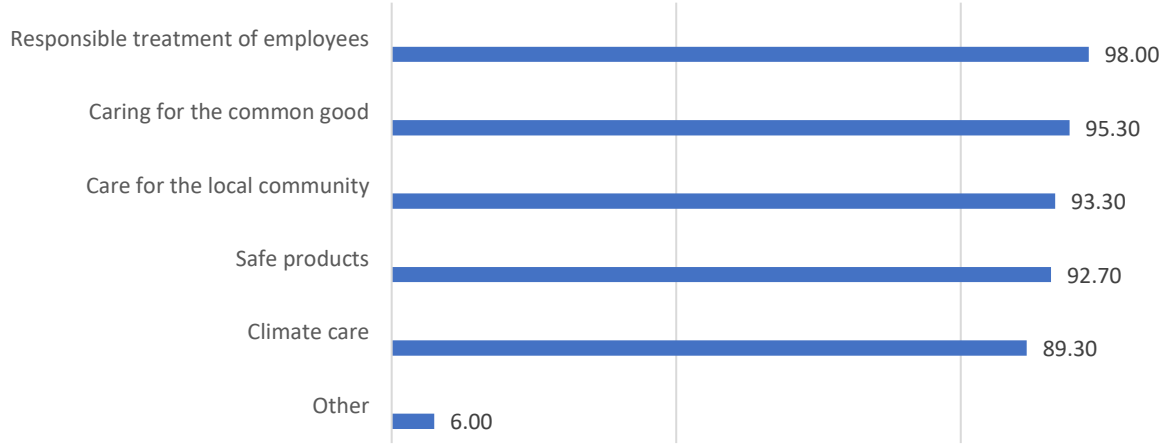

Figure 6. Areas in which corporate social responsibility should be manifested (n=150) in percentage
Source: own elaboration.

The presented results show the hierarchy of importance of various forms of corporate social responsibility, although the observed differences are small. Nine respondents chose the answer 'other'. They indicated the following areas: the area of education (2 people), the area of interpersonal relations (1 person), the area of corporate governance (1 person), the area of quality (1 person), the area related to acting for the good of enterprises (1 person), the area of supporting disabled people and their professional activation (1 person). 1 person indicated that corporate social responsibility should not be manifested in any area.

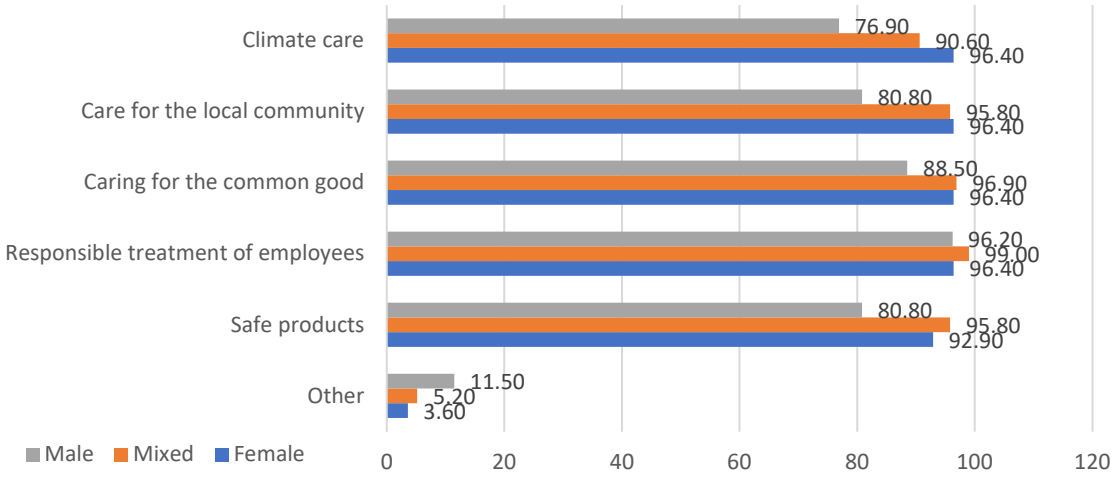

Figure 7. Gender social culture and declared areas of corporate social responsibility (n=150) in percentage
Source: own elaboration.

Social/psychological gender culture was a factor that differentiated the respondents' answers. The use of the chi-square test allowed us to conclude that the representatives of the male gender culture were statistically significantly less likely to indicate the following answers: 'safe products' (ch2=6.833813668, p-value = 0.028394321), 'care for the climate' (ch2=5.84971669, p-value = 0.047590482), 'care for the local community' (ch2 = 7.991562009, p-value = 0.023195361) than those assigned to the other distinguished types of social gender culture. The correlation between the answers and the represented type of social gender culture was weak. However, we did not observe any correlations observed between the type of enterprise (family/non-family) and the way the respondents answered this question.

The next question included in the survey questionnaire concerned the areas in which the companies represented by the respondents were socially responsible. The question was multiple choice.

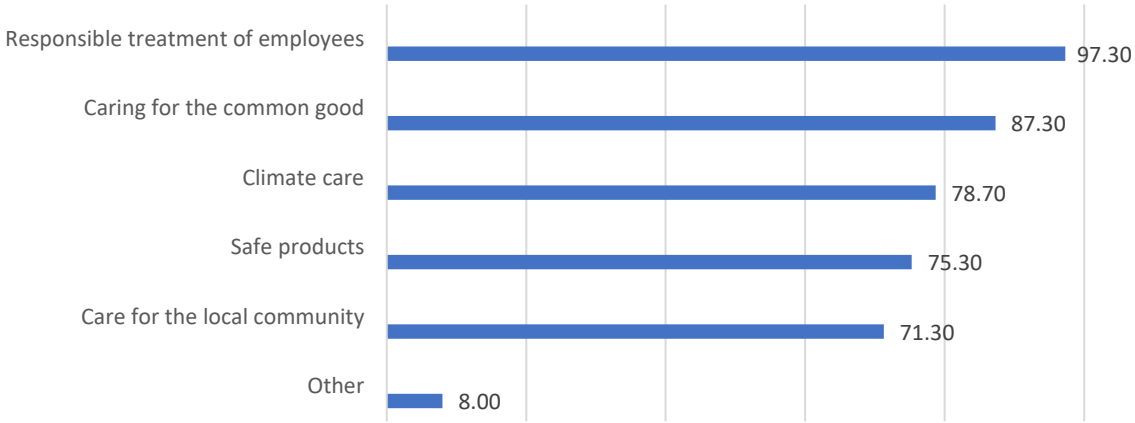

Figure 8. Real areas of social responsibility of enterprises run by respondents (n=150) in percentage
Source: own elaboration.

The presented results regarding the actual involvement of the companies in social activities in Figure 8 differ from the personal opinions of leaders on the need for businesses to engage in social activities in Figure 6. This may mean that capital needs for business development have priority over non-economic goals.

Eight respondents chose the answer 'other', indicating areas of social responsibility not mentioned in the cafeteria. The answers given by the respondents included carrying out activities for children (organising Saint Nicholas Day, helping children in an orphanage), carrying out activities to help

Ukraine, supporting sports initiatives, activities for ecology, and activities for local communities despite that in most cases they coincide with the proposals in the questionnaire.

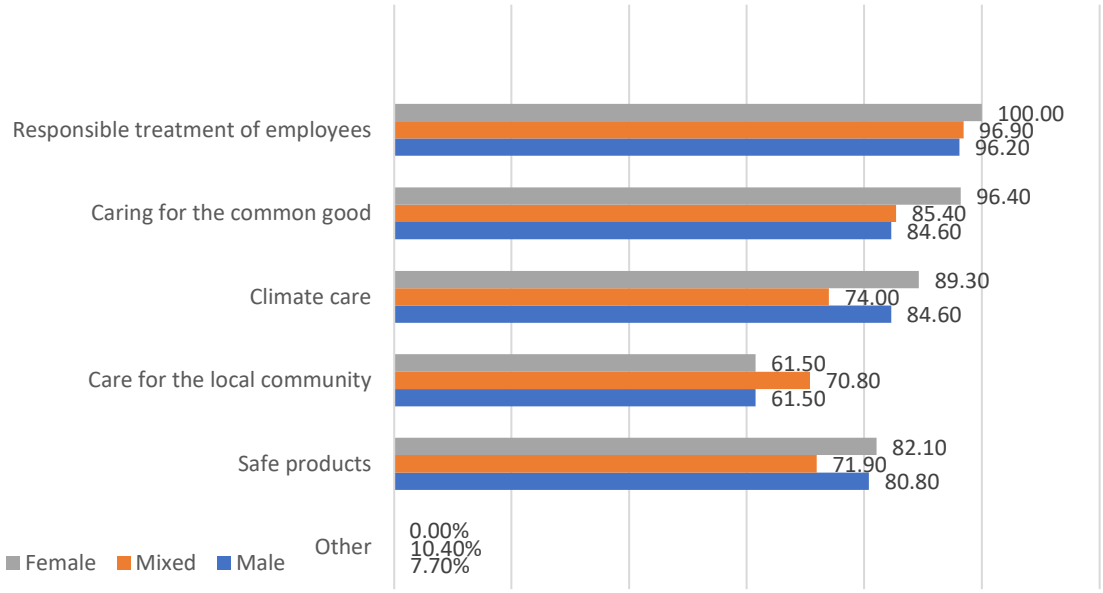

Figure 9. Areas of activities for social responsibility and the social culture of the respondents' gender (n=150) in percentage

Source: own elaboration.

Figure 9 shows the results of answers to the question regarding the areas in which the surveyed enterprises make efforts to promote corporate social responsibility, distinguishing the answers given by respondents assigned to the individual types of social gender culture. In this case, the chi-square test used did not show that social gender culture was a factor that differentiated the respondents' answers in a statistically significant way ($p>0.05$). It was also not the status of the company run by the respondents (family/non-family) ($p>0.05$).

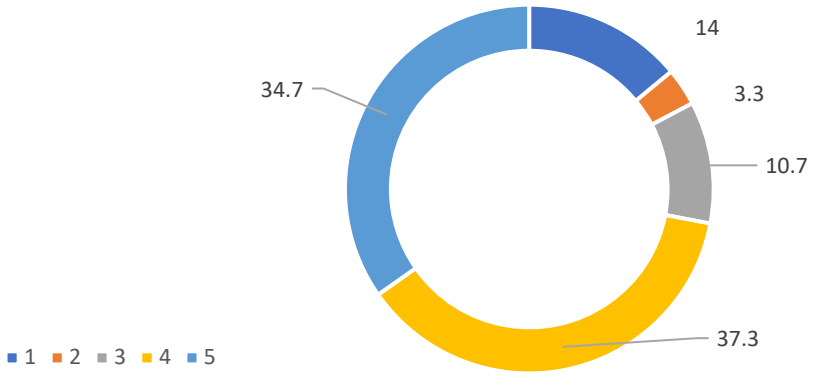

Figure 10. The intensity of activities undertaken for social responsibility (n=150) in percentage

Source: own elaboration.

In the next question, we asked the respondents to determine the intensity of their companies' social responsibility activities. The respondents assessed it using a 5-point scale, on which 1 meant that the company does not undertake social responsibility activities or these activities are sporadic, and 5 meant that it undertakes such activities with very high intensity. The question was closed, single-choice.

The largest number of survey participants answered this question with a rating of '3' – 56 people. In total, 52 people chose the rating '4' and 21 participants marked the rating '5'. Moreover, 5 and 16 respondents gave the ratings 1 and 2, respectively. The arithmetic mean of all the ratings given by the respondents was 3.45. The research results obtained in this way allowed us to conclude that the rep-

resentatives of the surveyed enterprises generally conduct activities in the area of social responsibility with slightly above-average intensity.

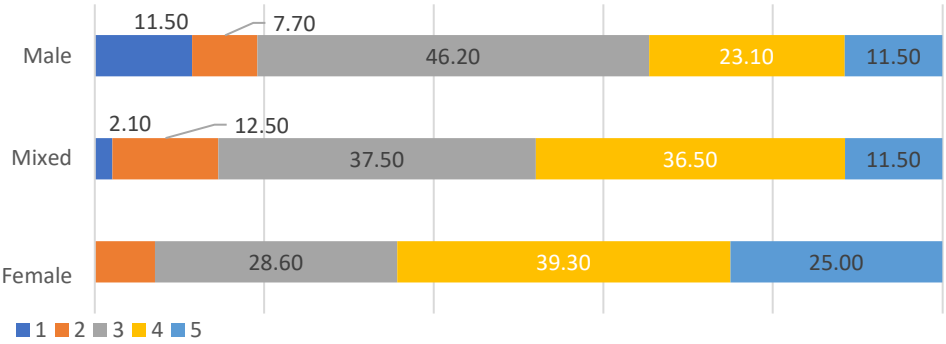

Figure 11. Intensity of activities for social responsibility and social gender culture (n=150) in percentage
Source: own elaboration.

Figure 11 shows differences in the assessments of respondents assigned to three distinguished types of social gender culture. The analysis of the results allowed us to conclude that the respondents assigned to the female gender generally gave ratings indicating a higher degree of intensity of activities undertaken for social responsibility than the respondents of the mixed and male genders. However, the observed differences were not statistically significant (p>0.05). In the way of answering this question, we did not observe any statistically significant differences between representatives of family and non-family businesses (p>0.05).

In the penultimate question in the survey questionnaire, we asked the participants to indicate whether their companies had plans to increase the intensity of social activities in the future. The respondents assessed it using a 5-point scale, where 1 meant that the company they run had no plans to increase the intensity of social responsibility activities, while 5 meant that such plans existed. The question was closed, single-choice. All survey participants answered it.

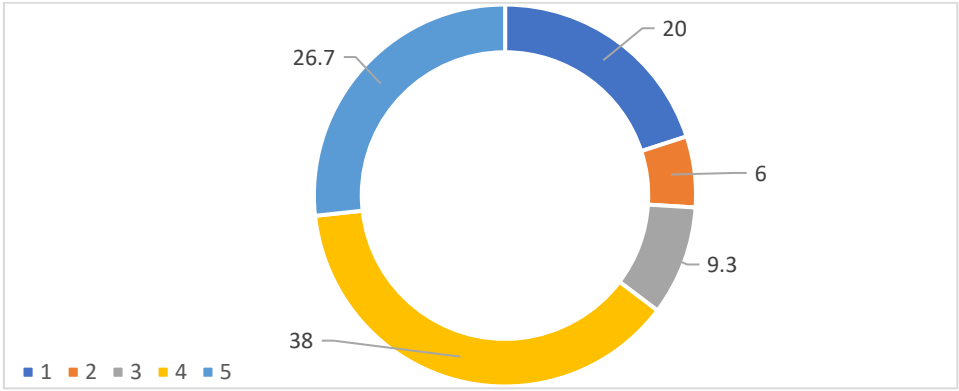

Figure 12. Plans to increase the intensity of social activities (n=150) in percentage
Source: own elaboration.

When answering the question about plans to increase the intensity of social activities undertaken, 30 people participating in the study marked the rating ‘5’ and another 40 respondents marked the rating ‘4’. A total of 70 out of 150 survey participants indicated that their companies intend to take action to increase the intensity of their social activities. In total, 57 respondents chose the rating ‘3’, 9 respondents chose the rating ‘1’, and ‘ 14 respondents chose the rating ‘2’. The arithmetic mean calculated for all the ratings given by the survey participants was 3.45. Thus, the surveyed leaders planned to increase the intensity of social activities to a moderate extent. The type of social gender culture or the status of a company (family/non-family) was not a statistically significant factor differentiating the respondents’ answers to this question (p>0.05).

The final research question (RQ8) concerned the relationship between the leaders' entrepreneurial orientation and their social responsibility. To find out the answer to the question formulated in this way, we decided to compare the results of answers to the question which aimed to determine the entrepreneurial orientation of the leaders with the results of answers to the questions related to their social responsibility profile. In no case did the chi-square test indicate a significant statistical relationship between entrepreneurial orientation and social responsibility of the surveyed leaders ($p>0.05$).

In light of the above, we can assume that we achieved the aim of the research project and solved the research problem. The leaders of the fastest-growing enterprises present three psychological gender cultures: male, female, and mixed, of which the latter dominates (64%). The respondents had a generally strong entrepreneurial orientation but with a relatively lower risk tolerance and a high awareness of the need for corporate social responsibility. Despite this, only half of them undertook international expansion and 18% of the respondents declared significant revenues from foreign markets and less than half of them have a positive attitude towards artificial intelligence. The differences in the impact of the identified psychological gender cultures of the leaders on selected entrepreneurial behaviours and social activity concerned only one dimension of entrepreneurial orientation and the importance of declared forms of social responsibility. The leaders presenting male gender culture showed a statistically significant greater willingness to compete in the sector and a lower orientation towards the care for climate, safe products and the care for local community compared to other cultures. We found no relationship between the entrepreneurial orientation of the identified gender cultures and their social characteristics.

Discussion

Since the research conducted is pioneering in nature, we are unable to compare its results to previous studies on similar issues. Carefully selected and cited literature including the theory of social roles, theory of higher echelons or social/psychological gender served as the context for the research project and the justification for its implementation. Moreover, the few articles on the psychological culture of gender in management presented in the literature review do not cover the scope or issues of the current research. There is a lot of literature devoted to the issue of 'gender' in management, but they treat this concept synonymously with 'biological sex'. These publications characterize the behaviour of biological men and biological women in managerial roles, disregarding the cultural context, *i.e.*, their psychological gender culture. This is the difference between them and the current paper. Therefore, the authors will refer to the extant literature relevant to the research topic and focus on those aspects that constitute research novelty and may be important for further research in the future.

The contemporary social role of a management leader, especially in small and medium-sized businesses, requires them to have both instrumental and expressive features. Instrumental features are necessary to design the enterprise's vision and mission, define its goals and strategies for their implementation, make bold decisions and face challenges related to the increasingly unpredictable environment and the growing intensity of competition and the development of broadly understood technical progress. In turn, expressive features help generate and deepen intellectual capital, create conditions of openness and support in the workplace, pro-innovation culture, teamwork and shared responsibility for the organisation. The research findings prove that it is actually possible for a person to develop both instrumental and expressive features, which determines professional success in management. In this respect, the research questions the assumptions of the social role theory, provides the basis for modifying the postulate of gender diversification in a team, considering the cultural dimension of gender in the theory of higher echelons, and finally confirms the validity of the concept of psychological gender.

The research results allowed us to outline a personality model consisting of 15 instrumental traits (out of 26 possible) and 15 expressive traits (out of 26 possible), which we identified as those with a high degree of occurrence among all the surveyed leaders (rated by them as high as 4 and 5). Table 2 provides a list of the most popular features along with the number of respondents declaring their intense occurrence.

Table 2. List of instrumental and expressive traits and the number of leaders identifying them at a high level (4 or 5)

Instrumental traits leaders number with the highest ratings		Expressive traits leaders number with the highest ratings	
Responsibility	145	Honesty	141
Ambition	132	Interpersonal relations	135
Decisiveness	126	Tolerance	133
Courage	119	Cooperation	132
Sensitivity to honour	117	Openness to others	129
Confidence	116	Family nature	125
Braveness	115	Peaceful attitude	123
Stubbornness	110	Humanitarianism	121
Leadership	96	Kindness	120
Readiness to fight	79	Modesty	117
Need for success	75	Caring	115
Strength and vigour	74	Empathy	115
Assertiveness	73	Searching for consensus	114
Competitive orientation	70	Need for security	117
Pride	67	Indulgence	114

Source: own study.

In general, the intensity of expressive features is greater than the intensity of instrumental features, which proves the growing importance of the former and breaking cultural stereotypes in social leadership roles. The identified model of personality traits of leaders of successful companies has cognitive value and we can consider it one of the project's achievements and the contribution to the discussion on managerial competences (Helfat & Martin, 2015).

The dominant gender culture among the leaders of the most pro-growth Polish enterprises is a mixed culture: androgyny (50 leaders) and unspecified culture (46 leaders), constituting a total of 64% of the sample. However, cross-defined cultures are also a form of mixed traits, only with a clear predominance of the traits of the opposite biological sex, and their share in the sample was approximately 11%. That is, a total of 75% of the surveyed leaders have greater potential for behaviours and adaptation to various situations than pure male and female cultures. Therefore, we may assume that these distinct, pure cultures have a lower probability of managerial success than a mixed culture and this may only increase in the case of eminently male sectors and eminently female sectors (Nakagawa & Schreiber, 2014; Schwab *et al*., 2016; Adusei *et al.,* 2017; Bae & Skaggs, 2019; Ali *et al.,* 2023). Although the study sample included only 6% of large enterprises, the size of the enterprise and other control variables were not related to the distribution of gender cultures. There was also no significant relationship between the nature of family/non-family enterprises and the distribution of gender cultures. The findings confirm the validity of the psychological concept of gender and the special personality potential of people representing mixed culture. Moreover, the presented results are consistent with previous research detecting a positive correlation between a manager's androgynous personality and the results of the business or division they manage (Jurma & Powell, 1994; Srivastava & Nair, 2011; Powell *et al*., 2021). Although family and non-family businesses did not differ statistically significantly in terms of gender culture distribution, the former are known for their patriarchal management system and problems related to family succession planning. The findings prove that successors may be women, who culturally are rarely considered as candidates for leaders. However, they may be much more qualified to take over the family business than their male counterparts in the family.

As expected, the entrepreneurial orientation of the leaders of the surveyed enterprises was relatively high. For each of the five assessed features, the cumulative percentage of ratings '4' and '5' was not lower than 60.0%. Three features of entrepreneurial orientation, *i.e.*, autonomy (83.3%),

pro-activity (77.4%) and readiness to compete in the sector (74.7%) turned out to be the most intense. Readiness for competitive struggle as the only feature of entrepreneurial orientation is positively and statistically significantly correlated with male gender culture. We can take this as evidence that this trait is uniquely instrumental. In the remaining dimensions of entrepreneurial orientation, there is no statistically significant relationship with the identified three gender cultures. The female culture also presents a high level of entrepreneurial orientation. This means that not all features/components of entrepreneurial orientation have to be instrumental. Innovation can be an expressive feature (Hisrich & Brush, 1984; Sandberg, 2013). Moreover, the presence of leaders in the sample, biological men with a female social culture, could have influenced the result. The identified structure of entrepreneurial orientation of the leaders of the surveyed enterprises has cognitive value. The relatively average level of the 'readiness to take risk' dimension makes us wonder about the possible reasons. Is it a matter of our national culture or a weak education system in Poland, especially management studies?

The profile of social responsibility of the leaders of the surveyed enterprises does not show a statistically significant relationship with the social gender culture or with the control variables, which was inconsistent with expectations. It seemed that female and possibly mixed social culture would show greater inclinations in the field of corporate social responsibility. Indeed, the responses show greater sensitivity of the female and mixed cultures to social behaviour compared to the male culture, but we did not detect any statistically significant relationship. The use of the chi-square test only allows us to conclude that representatives of the male social culture were statistically significantly less likely to indicate declarative areas of corporate social responsibility: 'safe products', 'care for the climate', 'care for the local community' than those assigned to the other distinguished types of social gender culture. Similarly, we assumed that the leaders of family businesses would be more active in this area than their non-family counterparts, which is not confirmed. The lack of a statistically significant relationship between entrepreneurial orientation (its dimensions) and the social involvement of the leaders proves, that they do not perceive social activity as an important opportunity to build a competitive advantage. Noteworthy, pro-activity is a dimension of entrepreneurial orientation that is highly prevalent among leaders. The explanation for this state may be that small and medium-sized enterprises experience a resource barrier, especially financial, in their further growth and development, and therefore give higher priority to economic goals than to social ones. The size of the enterprise and its financial needs may moderate the impact of high social awareness and expressive traits of the leaders on actual activity in the field of social responsibility, which refers to national culture with masculinism as a negative moderator in women's social activities in management teams, gender diversified (Peng *et al.*, 2022).

In the twenty-first century, in the conditions of ongoing globalization and digital transformation, international expansion seems to be a natural growth strategy and a way to increase the competitive advantage of enterprises. International expansion and its course are determined by the possession of products with high value-added, leader's competences: their industry and managerial knowledge, international experience, and entrepreneurial orientation. The research shows that nearly 70% of the surveyed enterprises either do not expand internationally or do so only occasionally. This is despite offering high value-added products, strong growth, recognition on the Forbes Diamond List, and, in most cases, having highly educated leaders. Only 18% of them declared intensive expansion into foreign markets (score 4 or 5). We can explain the results by the relatively low level of risk tolerance compared to other dimensions of the leaders' entrepreneurial orientation (the arithmetic mean of risk tolerance is 3.6 on a scale of 1-5) and their poor international knowledge and experience. The latter reasons result from the civilization delays of the Polish economy, which is still undergoing socio-economic transformation. Concerning the research goal, we did not find any statistically significant correlation between gender culture, the nature of family/non-family enterprises or other control variables and the undertaking and intensity of international expansion or the attitude towards artificial intelligence.

CONCLUSIONS

Summary

We shall formulate two conclusions with implications for science and economic practice. Firstly, biological women can and should achieve managerial success in business provided they acquire and develop instrumental features in the socialization process because they are crucial in fulfilling the social role of a manager. The share of women in employment in managerial positions is lower than that of men because women demonstrate instrumental features less often than men. It is a stereotype to claim that women in the corporate sector, consisting of entities operating in an increasingly unpredictable and competitive environment and dependent on the competences of their leaders, are discriminated against in managerial functions due to their biological gender. Just like men, women are required to have competences and the desired personality profile, necessary to meet the expectations of stakeholders in the internal and external environments. Secondly, the family environment and the education system are undoubtedly of the greatest importance in the process of shaping both instrumental and expressive features of a person during their socialization process. The family may be an anthropological product and it is difficult to program the desired changes in it towards educating and consolidating positive instrumental and expressive features at the same time. A high level of awareness of the benefits resulting from a wide repertoire of behaviours of the young generation and a belief in the validity of such socialization in the twenty-first century are required. The education system is better positioned to initiate such changes. Finland and Singapore provide positive examples, where policymakers have deliberately and consistently addressed the challenge of developing soft skills and entrepreneurial attitudes among young people.

Contribution

We can consider the results of the conducted research a contribution to the development of the following paradigms: managerial competences, the role congruity theory, the theory of higher echelons, and social/psychological gender culture. The research is the first attempt to identify the personality model of managers determining the strategic culture of the fastest-growing enterprises and its impact on the entrepreneurial and social behaviours of these enterprises. Personality traits once linked to traditional gender roles – instrumental traits to men and expressive traits to women – now often appear in combination. This shift reflects broader social, cultural, and moral changes influencing the socialisation process. The literature states that people who, in addition to personality traits typical for their biological sex, have developed personality traits of the opposite biological sex are creative, innovative, talented, and have a greater potential to achieve professional and life successes and satisfy their self-actualization needs than people with a clear, pure gender culture (Klimicka *et al.,* 1987; Faulkender, 1991; Bem, 1997; Woodhill & Samuels, 2023). The results of the conducted research positively verify this view in terms of performing the functions of leaders of strongly pro-growth enterprises by people, the vast majority of whom demonstrate a combination of instrumental and expressive features in their personalities, which allows them to benefit from a wide repertoire of behaviours. In this context, biological women, thanks to the acquisition of instrumental features (a necessary condition) in the socialization process, can play managerial roles in business, in a particularly demanding environment, and achieve spectacular successes. The implication of the research for the theory of top management teams is the postulate of their diversification in terms of cultural rather than biological gender.

Another achievement of the research is the demonstration for the first time that the concept of entrepreneurial orientation (Lumpkin & Dess, 1996) does not include only instrumental features, because we found no statistically significant relationship between each of the identified gender cultures and the individual components of entrepreneurial orientation except for one of these components, *i.e.*, readiness to compete in the sector. In this respect, we can recognize that the instrumental trait is statistically significantly related to the male gender culture.

Research Limitations

An undoubted limitation of the presented research is the sample size. Although the sample in relation to the entire population of enterprises on the Forbes Diamonds List (11 000 enterprises) is large compared to samples in traditional quantitative research, as it covered 1.36% of the enterprises, its larger size would allow for examining the relationships between smaller subgroups of gender culture, separately between androgynes, unspecified culture, female intersectional culture, male intersectional culture and their entrepreneurial orientation, entrepreneurial behaviours, social responsibility. Obtaining even 150 questionnaires with complete answers was difficult due to the sensitive topic of the study and the general reluctance of entrepreneurs in Polish culture to participate in this type of scientific endeavours. Those leaders who refused to answer the questions claimed that they were too personal, despite the assurances of the anonymity of the study.

The research intention was, among others, to identify gender cultures and their impact on the entrepreneurial behaviours of leaders of enterprises with spectacular growth dynamics and therefore achieving significant strategic successes. The purposive selection of the sample ran from position 1 on the list to 2016, *i.e.*, the sample constituted 7% of the 2016 highest-ranked enterprises. Therefore, the sample included mainly micro, small and medium-sized enterprises, which, due to their size, find it easier to achieve high growth dynamics than large ones. The regularities detected in the study may be different for a group of large enterprises in terms of international expansion or actual expenditure on sustainable development.

Directions for Future Research

Research on the impact of managers' gender culture on organisational behaviours should be continued. Firstly, scholars should undertake similar research on an international scale, in various cultural circles, to determine the possible role of national culture as a moderator of results. Masculinism or feminism are possible dimensions of national culture according to Hofstede (2010). Moreover, countries around the world are diverse in terms of civilization development and the way enterprises compete (Porter, 1990), which may determine the distribution of the gender culture of leaders among the population of the fastest-growing enterprises.

We also suggest repeating the research on the population of large Polish enterprises, also from the Forbes Diamond List. Expectedly, larger enterprises, due to the achieved potential, *i.e.,* material resources, experience, knowledge, and higher strategic culture, undertake foreign expansion more often and more intensively and have greater financial possibilities to engage in sustainable development than small and medium-sized enterprises. This may mean different requirements for instrumental and expressive qualities in leadership positions.

It would be worth repeating the research among public utility organisations and those in the public/state sector. In most cases, apart from the secret services, army etc. one would expect the dominance of expressive features in the personalities of their leaders. However, linking the gender culture of managers with the criterion of management effectiveness of organisations of this type will constitute a significant difficulty.

Among other suggestions for future research on enterprise leaders, we indicate the inclusion of control variables describing the nature of a sector: male, female, neutral, having formal managerial education or not, as well as determining gender culture among startup founders. In the latter case, the relationship between gender culture and entrepreneurial orientation would be established with greater precision. It would also be worthwhile to measure the entrepreneurial and social behaviours in equal groups representing the three identified gender cultures.

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Acknowledgements and Financial Disclosure

The article came into being within the project – in the framework of the research activity of the Management Faculty and therefore was financed from the Faculty's own funds.
The authors would like to thank the anonymous referees for their useful comments, which allowed to increase the value of this article.

Use of Artificial Intelligence

Our article is free of AI/GAI usage apart from searching engine in the literature review.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.07

Greenhorns or old stagers: Is equity crowdfunding in Poland inclusive?

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ABSTRACT

Objective: The article aims to indicate whether equity crowdfunding (ECF) in Poland is inclusive and whether the attributes of inclusivity influence the campaign's success.

Research Design & Methods: The research covers all ECF campaigns in Poland from 2012-2022. The data collection includes details on equity offers, the companies' top management teams (TMT) structure, and crowdfunding campaign results. We implemented the ANOVA analysis to verify the hypotheses, and further, based on the data obtained, we built the regression models.

Findings: Most of the surveyed entities are characterized by a lack of inclusive attributes. The dominant part of entities founded by ECF are companies located in Warsaw or the capitals of voivodships, managed by men aged between 31-59.

Implications & Recommendations: The results show that there is no reason to believe that issuers who are gender inclusive will be more successful in ECF. Moreover, there is no evidence to reject the claim that the inclusiveness of the issuer measured by the age of the CEO can affect the success of the issue. However, the location of the issuer can affect the success of an ECF offer.

Contribution & Value Added: Previous research on inclusivity has been conducted mainly in countries with high ethnic diversity. This research identifies the attributes of inclusiveness appropriate for ethnically homogeneous countries. Moreover, we conducted a comprehensive analysis of companies active in the ECF market in Poland.

Article type:	research article
Keywords:	entrepreneurship; equity crowdfunding; financial inclusion; crowdfunding campaign success; equity financing
JEL codes:	M13, L26, G23

Received: 21 October 2024 Revised: 26 March 2025 Accepted: 2 April 2025

Suggested citation:
Kordela, D., & Kicia, M. (2025). Greenhorns or old stagers: Is equity crowdfunding in Poland inclusive?. *International Entrepreneurship Review,* 11(3), 161-178. https://doi.org/10.15678/IER.2025.1103.07

INTRODUCTION

In the beginning, people saw crowdfunding as a funding form suitable mainly for charity projects, and its donation model gained significant interest. Equity crowdfunding (ECF) developed slower, mainly because of regulations, legal constraints, and the question of trust. However, after the financial crisis of 2008-2010, scientific research confirmed that its importance as a financial source appropriate for new ventures increased (Moritz & Block, 2014; Lukkarinen *et al*., 2016). Previous study showed ECF to be an adequate form of financing for entities with limited access to funds (Schwienbacher & Larralde, 2010; Ahlers *et al*., 2015; Brown *et al.*, 2018; Lukkarinen *et al.*, 2022) mainly because of the lack of credit history, size, and innovative sector. Thus, people saw ECF as a form for entrepreneurs who just started their business, and have no or little experience. The terms such as 'new venture,' 'newly born entrepreneurship,' or 'enterprise in early stages' characterize only the entity itself as a legal form. They characterise neither the entrepreneurs nor the founders. It is impossible to check and asses the entrepreneurship profile cannot only based on the entity's age. The key figure is the entrepreneur and their characteristics. Research on reward crowdfunding highlights the importance of personal attributes and strategic planning in shaping

growth aspirations in research on reward crowdfunding (Beier & Wagner 2017), similar to ECF studies – among others by Cumming *et al.* (2021), Vismara *et al.* (2017), and Butticè and Vismara (2022).

Despite the growing body of literature on ECF, several research gaps remain. These include the need for longitudinal studies to examine the long-term impact of ECF on firms and investors, as well as the integration of behavioural theories (*e.g.*, signalling theory, agency theory) to better understand investor and entrepreneur dynamics (Huynh, 2016; Chang, 2023). Moreover, people increasingly use ECF platforms to support sustainable technological initiatives, particularly those addressing social and environmental challenges. However, communicating the credibility of sustainability intentions remains a challenge for entrepreneurs seeking funding through ECF. Future research should explore how ECF platforms can better facilitate the co-creation of sustainable solutions and how investors perceive the value proposition of sustainable projects (Yanez-Valdes & Guerrero, 2023).

One of the most significant challenges in ECF is information asymmetry between entrepreneurs and investors. Entrepreneurs often possess more information about their ventures than investors, leading to adverse selection and moral hazard (Huynh, 2016; Mazzocchini & Lucarelli, 2022). Hence, the characteristics of the entrepreneur seem to be an important factor in investment decisions on ECF.

In this article, we focus on the entrepreneurs' characteristics concerning the ECF campaign in Poland. The importance of the Polish economy in the CEE Region is based, among others, on the size of the country and the inhabitants number. It is a market with significant purchasing power. Moreover, Poland has a well-developed capital market. The Warsaw Stock Exchange was ranked fifth based on capitalization in 2021 among 15 European stock markets and has a dominant position in the region (Kicia & Kordela, 2024). ECF has developed a lot recently in Poland. To the best of our knowledge, there is no complex research on entrepreneur profiles financed by ECF in Poland, we try to fill this research gap.

We aimed to indicate whether ECF in Poland is inclusive and whether the attributes of inclusivity influence the campaign's success. We treated the title metaphorically, so the old stager was a synonym for a middle-aged white man from the big cities. As opposed to greenhorns, which tend to be young, and not evident in business, considering experience, background, gender, and other personal characteristics. Another goal was to identify factors proving the inclusive nature of ECF (World level, Poland level) analysis of the relationship between the characteristics of enterprises and entrepreneurs and the funding.

In the next section, we will focus on literature underpinning, which was the basis for the hypotheses development. The third section will include the methodology. In the fourth section, we will present and discuss the results. We will conclude by emphasizing the most important results, indicating the limitations and future research directions.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The topic of financial inclusion is gaining importance, the Web of Science Core Collection (WoS) shows more than 8 440 publications connected to this topic, of which over 1 604 are in the field of economics, 905 in the business finance area, more than 620 in business, and over 530 in management. The number of citations is also growing dynamically. The literature provides many definitions of financial inclusion. A few years ago, scholars typically defined financial inclusion as using formal financial services (Allen *et al.*, 2016), and associated it primarily with banking and access to traditional financial intermediaries. A broader definition suggests that financial inclusion means ensuring access to formal financial services and products, such as transactions, credit cards, payments, savings and insurance, that are provided in a sustainable manner (Singh & Singh Kondan, 2011). Another approach defines it as a process that ensures the ease of access, availability, and usage of the formal financial system for all economy members (Sarma & Pais, 2011). Increasingly, financial inclusion is understood as access to financial services, not necessarily to the services of the banking sector, and not necessarily to services provided by traditional financial intermediaries. It is an essential process, particularly in least-developed countries, where inequality in wealth distribution can lead to financial exclusion, and economic growth is crucial for increasing financial inclusion (Cicchiello *et al.*, 2021b).

Microfinance has an crucial role in financial inclusion (Ghosh, 2013; Brown *et al.*, 2016; Macchiavello, 2017; Mushtaq & Bruneau, 2019; Milana & Ashta, 2020). In conditions of failure to meet the needs of enterprises by traditional financial intermediaries, bottom-up initiatives such as microfinance or crowdfunding may provide capital to the entities. Based on an analysis of research conducted in African countries, Lwesya and Mwakalobo (2023) concluded that small and medium enterprises face significant obstacles to fulfilling their potential to grow because of a lack of finance and inadequate access to sources of finance. Similar problems resulting from other reasons are also noticeable in Europe. Due to the low profitability of banks and relatively strict rules and regulations aimed at combating risk-taking after the financial and debt crises, access to capital at the early stage of enterprise development is insufficient (Blaseg *et al.*, 2021). Among research topics connected to microfinance, the cluster regarding constraints on microcredit for SMEs is the largest (Lwesya & Mwakalobo, 2023). ECF is a chance for SMEs to fill the financial gap (Kim & De Moor, 2017).

Crowdfunding is an initiative started by the grassroots movement, not by major financial institutions. Thus, we may perceive the crowdfunding development as increasing the availability of funds, as pro-inclusive activity. The literature refers to pro-inclusive changes in the capital market as a democratization process of capital markets. This is a situation where the capital markets can create an environment in which entrepreneurs and investors typically underrepresented in these markets can participate (Mollick & Robb, 2016). Hence, the financial markets' democratization means their openness, lower requirements, easier access to funds, higher involvement of small investors, and lower bureaucratic constraints, which make them more inclusive. These two terms are therefore closely related. Financial inclusion can lead to a reduction in the cost of capital, the improvement of financial management, and the protection of investors and borrowers from fraud. At last, an inclusive financial system ensures safe saving practices and generally facilitates a range of efficient financial services, leading to increased efficiency and prosperity (Sarma & Pais, 2011). Scholars see ECF as a promising way to promote financial inclusion (Kim & De Moor, 2017), and describe it as a fintech tool for sustainable financial inclusion in the financial system (Venturelli *et al.*, 2020). Moreover, Vismara (2019) states that crowdfunding has an essential contribution to the inclusivity and democratization of financial markets considering both the needs of entrepreneurs and the expectations of investors. The subject is worth exploring, there is still a little research on it. The WoS gives 48 records on crowdfunding and financial inclusion (date to March 2025). None show the situation in the CEE region, which differs from Western countries based on its economics and political past, and the homogeneous ethnic origin of the inhabitants. To contribute to that research area, we explored the relationship between ECF and the financial inclusion of entrepreneurs. In line with the work of Butticè and Vismara (2022), we focused on entrepreneurs' inclusivity understood as the inclusion of silver entrepreneurs (we also added the inclusion of young ones), the inclusion of entrepreneurs in rural or peripheral areas (outside the capital of Poland, and outside of voivodeship capitals), as well as the inclusivity of women entrepreneurs, which we added based on literature review. The qualities that characterise people in TMT positions are called inclusiveness attributes. Research focused on financial inclusion and crowdfunding analysis of various attributes of inclusion.

In ethnically diverse societies like the US, race is a very important factor of entrepreneurship inclusion another is gender, geographical location, firm age or founder age, and even education (Figueiredo & Bendelá, 2024).

Trying to find the answer to whether crowdfunding democratizes access to funding, Mollick & Robb (2016) considered two features, *i.e.*, geographic and gender bias. The literature does not provide explicit answers on the impact of gender on the success of an ECF campaign. For example, regarding gender bias, Mollick and Robb (2016) recall numerous studies proving that female entrepreneurs generally are active in low capital requirements sectors, and are less active in both angel investors and venture capital markets. Further, in the case of crowdfunding, Lwesya and Mwakalobo (2023) revealed just four publications related to gender and ECF. However, the number seems to be higher and is increasing, and scholars have conducted studies on gender and crowdfunding from different perspectives (Horvat & Papamarkou, 2017; Geiger & Oranburg, 2018; Venturelli *et al.,* 2020; Gafni *et al.*, 2021; Wesemann & Wincent, 2021; Zhao *et al.*, 2021; Figueroa-Armijos & Berns, 2022; Prokop & Wang, 2022; Wang *et al.*, 2023a; Davis *et al.,* 2023; Wang & Prokop, 2025).

To the best of our knowledge, Horvat and Papamarkou (2017) conducted one of the first studies on crowdfunding and the issue of gender involvement. In their research, they considered data from one of the leading UK-based ECF platforms. Research shows that women entrepreneurs benefit from higher fundraising success rates in ECF, the campaigns led by female entrepreneurs are slightly more successful than male-led campaigns (Horvat & Papamarkou, 2017). This is in line with the research by Zhao *et al.* (2021). They studied 259 projects from ECF platforms in China and found that female entrepreneurs are more likely to receive funding through ECF than their male counterparts. This, in turn, is consistent with Cicchiello *et al.* (2021a), who found that having at least one woman on the board of companies seeking equity financing increases campaign success rates. However, the conclusions of another study by Cumming *et al.* (2021), are not consistent with the results mentioned above. According to them, there is no evidence for a higher likelihood that women attract investors. Similar results come from research conducted in the USA, where it was proven that campaigns raise significantly less funding as the target amount increases when the leading signatory is female (Geiger & Oranburg, 2018). In comparison, Prokop and Wang (2022) found that female-led ventures have comparable results in raising capital to those without women. No advantageous effect for female entrepreneurs in crowdfunding indicates Wang *et al.* (2023b). These conclusions align with the results from the French ECF platform (Andrieu *et al.*, 2021). The research revealed that the presence of women in top management positions even reduces the likelihood of funding. Moreover, the representation of women as leaders of crowdfunding campaigns is much lower (only 9.73%) compared to French statistics about women entrepreneurship (which is 39%) (Andrieu *et al.*, 2021). There are many contradictions in the research results. The latest study based on data from a Chinese ECF platform shows no significant funding difference between entrepreneurship led by men and women. Moreover, mixed-gender teams outperform single-gender teams (Chuang *et al.*, 2025). Cross-sectional research conducted in 64 countries indicates that being a female entrepreneur (or a rural person) as a key characteristic of an individual increases the likelihood of financing a project fully (Figueroa-Armijos & Berns, 2022). Research on women's project financing is also inconclusive. Women as crowdinvestors are more likely to fund projects from female entrepreneurs (Bonvino *et al.*, 2025). While, previous research suggests otherwise, namely that female investors are more likely to invest in projects strongly supported by men (Mohammadi & Shafi, 2018). Since the findings are inconclusive, we wanted to contribute to this discussion. Perhaps due to cultural factors or the degree of development of the crowdfunding market in the studied countries, the results are not clear, hence there is a need to further explore the topic. The women in Poland are underrepresented in business, their share in the business is below the EU average, and to be more visible, and to succeed they need to be better prepared for competition. Thus, hypothesised:

H1: Companies with women in top management team (TMT) members are more successful in ECF offerings.

Cumming *et al.* (2021) have not only studied the relationship between gender and ECF. Moreover, they also checked the relationship between age and crowdfunding campaign success. They noticed that studies on ECF had neglected age issues. They cite the examples of Bill Gates (founder of Microsoft) and Mark Zuckerberg (co-founded Facebook), who founded companies at the age of nineteen as examples of the importance of young entrepreneurship. When examining the propensity to the entrepreneurship of novices, they noticed that it has a U-shaped age trend, falling around the age of 60, they also distinguished the age of 30 as the limit for propensity to work full-time (Zhang & Acs, 2018). The research indicates ECF seems to be an adequate form for innovative entrepreneurship, to fund projects with financing handicaps on the traditional financial market, and to build financing opportunities for young entrepreneurs and silver entrepreneurs. On the one side, there is little publication on age and ECF. On the other, some assumptions are pointed out about the adjustment of crowdfunding for young entrepreneurs. Conducting the analysis, we tried to fill this gap.

Hence, our following hypothesis considers age as an attribute of inclusivity.

H2: Companies with age-inclusivity top management team (TMT) members (under 30 or over 60) are more successful in equity crowdfunding offerings.

There is relatively little research on the influence of geographic location on the success of a crowdfunding campaign. A study on the reward model of crowdfunding demonstrates that since it is based on innovative IT solutions, it makes the expectation to constrain the geographical bias. At the same time, it emphasizes the role of intermediaries and the importance of addressing gender equality (Kromidha *et al.,* 2023). However, in the case of reward-based crowdfunding, there are studies indicating its uneven development across the US (Gallemore *et al.*, 2019), or a negative relationship between the geographic distance of funders and the success of crowdfunding projects (the farther a funder is located from the project, the lower the probability of the project's success) (Omrani *et al.,* 2022). There is still a gap regarding the geographical distance and ECF (Butticè & Vismara, 2022). The results of the studies on musical projects show crowdfunding thanks to the involvement of the internet relaxes a geographic constraint (Agrawal *et al.*, 2010). However, it concerns the geographic distribution of funders, not the projects themselves. Scholars studied the locations of campaigns founder for example in global cities (like Berlin, Bangalore, San Francisco, or Shanghai). Conclusions indicate the influence of location on campaign success, campaigns from global cities are more successful and have more foreign funders (Chakravarty & Ahsan, 2023). The site counts in a supply of crowdfunds, in more populated and prosperous regions the sources of funds are higher (Rostamkalaei & Freel, 2023).

The subject of our study was entrepreneurs' inclusivity. In this field, Roma *et al.* (2017) found the geographic location of the venture may influence ECF performance. Moreover, the geographic location has also served as a variable in a few other ECF research (Zhao *et al.,* 2021). The most recent research proves that spatial distance limits financial activity. Moreover, the number of ECF investments decreases with geographic distance (Cai *et al.*, 2024). In Poland, similar to many other countries, the capital is the business centre. Therefore, we wanted to check the campaign outcomes of firms in and outside the capital. In general, it seems that the Internet reduces the importance of location, as a consequence, crowdfunding would make it easier for entities outside the capital to raise funds. Agrawal *et al.* (2015) indicate ECF will increase financing opportunities by reducing distance-related costs. The relationship between success in ECF and geographical location differs among the countries.

In Brazil, entrepreneurs located in metropolitan areas are less likely to succeed. There are the following explanations. Firstly, in the rural areas, there is less competition, and as a consequence, it is easier to attract the interest of investors. Secondly, metropolitan companies have handicaps like greater competition making it more challenging to attract and impress potential investors (Figueiredo & Bendelá, 2024). In turn, on German market support is focused rather on projects that are closer to residence place (Wang & Prokop, 2025). The national capital tends to be an area with a higher average disposable income compared to other cities and a higher capital concentration. Therefore, we tested whether the location of a company's headquarters in Warsaw could be important for the success of crowdfunding offers in Poland. As crowdfunding is perceived as a complement to 3F financing, and the local community often actively participates in financing the crowdfunding campaign, we formulated a hypothesis:

H3: Companies outside voivodeships' capital cities are more successful in equity crowdfunding offerings.

Considering all the above, in our research we pointed out the following attributes of inclusivity: the board of management with female member(s), the supervisory board female member(s), the age of the CEO (under 30 or over 60), the location of headquarters outside voivodeship's capital cities. Poland is an ethnically homogeneous country. In the study, we found the share of foreigners in TMT to be non-statistically significant.

Despite its potential to democratize access to capital, ECF has not fully addressed the funding disparities faced by underrepresented entrepreneurs, such as women and ethnic minorities. While ECF has reduced structural barriers for some groups, gender and racial biases persist among investors, limiting its inclusivity. Further research is needed to identify strategies to enhance diversity and inclusion in ECF markets (Chang, 2023; Paul & Rena, 2024). That research gap, related directly to inclusiveness and indirectly to understanding investor behaviour in ECF inspired us. The above-presented research pointed out the investor's and entrepreneurs' behaviour regarding inclusivity attributes. We follow the

way. However, first of all, we comprehensively examined all three attributes to get the whole picture. Secondly, we studied the Polish market, which was not the subject of previous papers.

We formulated the following research question: Are there differences between entities with inclusive attributes and other entities in the effects of crowdfunding campaigns (size of the goal, amounts raised, degree of goal achievement, number of investors)? Our hypothesis investigated the relations between chosen attributes of inclusivity and the success of the ECF campaign.

RESEARCH METHODOLOGY

Sample and Data Collection

The study subject was the campaigns of companies that raised capital on crowdfunding platforms in Poland in the period 2012-2022. Data on all ECF campaigns that took place during this period was collected in a public database by Trzebinski[1] and provided the authors with a starting point for analysis. We removed all records involving suspended or cancelled campaigns and entities whose data were unavailable in the National Court Register. In the following step, we collected additional data on TMT size, gender structure, age, and headquarters location at the period of offering. We retrieved data manually for each venture from a public database of the National Court Register. Again, records with missing data on TMT members or headquarters were removed from the database. For the final analysis, we accepted data on 259 ECF campaigns carried out by 220 companies out of 280 equity campaigns included in the initial sample.

Based on the obtained data, we aimed to identify the characteristics of enterprises using ECF, and thus further diagnose whether ECF in Poland supports financial inclusion. We considered an entity to be inclusive if at least one of the following conditions was met: there was a woman on the management or supervisory board, the entity was managed by a person under the age of 30 or over 60, a foreigner sat on the management board or supervisory board, the entity was located outside the voivodeship capital[2] (Figure 1).

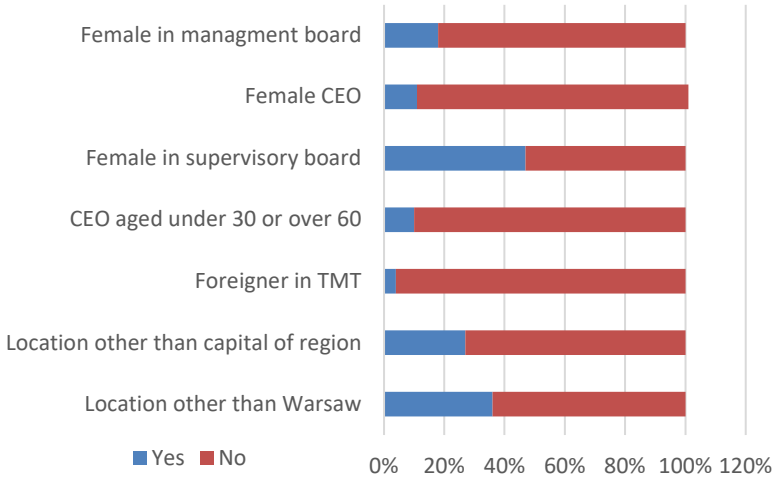

Figure 1. Main traits of the entities included in the sample
Source: own elaboration.

The collected data indicated that entities with inclusive attributes build the minority in the sample. Our research showed that women were on the boards of 18% of companies that use ECF. This is a slightly better result compared to the whole of Poland. Research shows that women are in about 17% of management boards of public companies, while in the European Union, it is about 30%. The vast

[1] https://airtable.com/shrXxy1MnmVD3hFuo/tblCtdOZ7FNdfdCI9/viwIMdWZAeI7ZdHPW?backgroun-Color=green
[2] The term 'top management team' (TMT) is used in business and academia to refer to the relatively small group of the most influential people in a company. The structure of companies, and companies' bodies differ between countries, legal forms, and economic systems. We used this term to refer to members of the management board and the supervisory board.

majority of companies included in the sample (90%) were managed by people aged 31 to 59. Just 27% of entities active on ECF platforms were located outside the voivodeship capital, furthermore, 64% of companies were located in Warsaw (the capital of the country).

Table 1 presents the main descriptive statistics of the campaigns included in the sample. The average and median values of the set goal of the campaigns were higher than the average and median values of the results. Thus, considering the whole sample the companies received less funds than planned. However, we also analysed campaigns that were suspended or withdrawn before the end of the deadline, partly due to low interest in the offer.

Table 1. The main descriptive statistics of the campaigns included in the sample, all are valued in PLN

Variable	Mean	Median	Lower quartile	Upper quartile	Minimum	Maximum
Goal in PLN	2 031 224	1 923 135	982 309	2 962 494	50 000	5 000 000
Result in PLN	1 142 968	747 315	226 917	1 577 250	4 726	4 550 000

Source: own study based on a database by Trzebiński, Wrocław University of Economics, Poland, https://airtable.com/shrXxy1MnmVD3hFuo/tblCtdOZ7FNdfdCI9/viwIMdWZAeI7ZdHPW?backgroundColor=green (DOA 10 May 2023).

Model and Variables

We divided the collected data into two groups. The first group of variables included measures of the effectiveness of equity-based crowdfunding offers. The second group included measures that could determine this effectiveness as indicated in the literature review, specifically those related to the inclusiveness of crowdfunding.

We used the following variables to describe the effectiveness of crowdfunding campaigns:

- *SuccessRate* – continuous variable, the ratio of the capital collected in the equity-based crowdfunding offer (*Funded*) to the target value of the offer (*Goal*); values equal to or greater than 1 represent the success of the offer, otherwise, failure to meet the goal;
- *Investors* – discrete variable, number of investors who responded to the offer and invested capital in stocks or shares; while it is difficult to arbitrarily indicate any minimum level of committed investors that can be considered satisfactory, a higher number of investors can be considered an indicator of success, depicting a grander scale of response to the offering and mobilization of capital;
- *Funded* – continuous variable, the value of capital collected in the equity-based crowdfunding offer in Polish zloty; the higher amount of capital collected indicates a positive reception of the investment proposal;
- *FundedToEquity* – continuous variable, the ratio of the capital collected to the value of the equity offering;
- *IsSuccess100* – binary variable, equal to 1 if the financial goal of the offer has been achieved or exceeded, or 0, otherwise;
- *IsSuccess80* – binary variable, equal to 1 if at least 80% of the financial goal of the offer has been achieved or 0, otherwise; the variable assumes a less restrictive approach to recognizing the offer as successful;
- *IsSuccess60* – binary variable, equal to 1 if at least 60% of the financial goal of the offer has been achieved or 0, otherwise; the variable takes an even more liberal approach to deeming an issuance successful, and was introduced to check if loosening the requirements to meet the financial target would reveal a different set of factors; the median *SuccessRate* of all observations is 0.66 indicating that a level of over 60% of the financial goal of the equity-based crowdfunding offer can be also considered as a success.

Table 2 provides descriptive statistics of the variables.

Table 2. Descriptive statistics of success measures of equity crowdfunding campaigns in Poland in 2012-2022

Variable	N	Minimum	Maximum	Average	Lower quartile	Median	Upper quartile
SuccessRate	259	0.0000	3.3333	0.6427	0.2100	0.6600	1.0000
Investors	235	0	9 125	941	51	115	322
Funded, PLN	258	4 726	4 550 000	1 205 163	278 763	881 364	1 678 179
FundedToEquity	195	0.42	50.00	12.87	8.00	11.00	17.34
IsSuccess100	258	0	1	0.37	–	–	–
IsSuccess80	258	0	1	0.42	–	–	–
IsSuccess60	258	0	1	0.51	–	–	–

Source: own study based on a database by Trzebiński, Wrocław University of Economics, Poland, https://airtable.com/shrXxy1MnmVD3hFuo/tblCtdOZ7FNdfdCI9/viwIMdWZAeI7ZdHPW?backgroundColor=green (DOA 10 May 2023).

The second group of variables describes offers and the issuers. We considered these variables as potential factors for the offer's success:

- *IsFemBoard* – dummy variable equal to 1 if there was at least one woman as a member of the management board member at the time of the offer, or 0 otherwise;
- *IsFemCEO* – dummy variable equal to 1 if a woman was CEO at the time of the offer, or 0 otherwise;
- *IsFemSupBoard* – dummy variable equal to 1 if there was at least one woman as a member of the supervisory board at the time of the offer, or 0 otherwise;
- *IsCEOun30* – dummy variable equal to 1 if the CEO was under the age of 30 at the start of the offering or 0 otherwise;
- *IsCEOov60* – dummy variable equal to 1 if the CEO was older than 60 at the time the offering began, or 0 otherwise;
- *IsOutProvCap* – dummy variable equal to 1 if the company's headquarters was located outside the regional capital or 0 otherwise; a variable entered into the model similar to the research (Zhao *et al.,* 2021);
- *IsInWarsaw* – dummy variable equal to 1 if the company's headquarters was located in Warsaw or 0 otherwise; a variable introduced into the model to check the importance of Warsaw as the capital of Poland and the attractiveness of the place, which may, in the opinion of investors, offer a potentially more significant chance of business success for the idea being financed;
- *Goal* – continuous variable, the amount expressed in Polish zloty, the value of the issue goal as communicated by the issuer with the launch of the offering;
- *Year* – the year of the issue;
- *LegalForm* – discrete variable, describing the form of business: 1 – simple joint-stock company, 2 – joint-stock company, 3 – limited joint-stock partnership, 4 – limited liability company, 5 – limited liability limited partnership; from the point of view of investors, joint-stock companies may be seen as more attractive, given the ease of capital entry and exit;
- *IssuePrice* – continuous variable describing the proposed issue price per share or share in an ECF offering;
- *BoardMembers* – discrete variable, the number of board members who were serving in the company at the time of the launch of the issue;
- *YearCEOBorn* – the year of birth of the CEO; the variable extends the dimension of inclusivity of the company contained in the discrete variables *IsCEOun30* and *IsCEOov60;*

We used the variables *IsFemBoard*, *IsFemCEO,* and *IsFemSupBoard* to verify hypothesis H1. The variables *IsCEOun30*, *IsCEOov60,* and *YearCEOBorn* served to verify hypothesis H2. The variables *IsOutProvCap* and *IsInWarsaw* served to verify hypothesis H3. We used all the variables indicated above to identify the success factors of ECF offers. Table 3 provides descriptive statistics of the variables defining the various dimensions of the success of the implemented ECF campaigns.

Table 3. Descriptive statistics of inclusiveness factors and potential success of equity crowdfunding campaigns in Poland in 2012-2022

Variable	N	Minimum	Maximum	Average	Lower quartile	Median	Upper quartile
IsFemBoard	259	0	1	0.18 (0.39)	–	–	–
IsFemCEO	259	0	1	0.11 (0.31)	–	–	–
IsFemSupBoard	259	0	1	0.47 (0.50)	–	–	–
IsCEOun30	247	0	1	0.06 (0.24)	–	–	–
IsCEOov60	247	0	1	0.04 (0.20)	–	–	–
YearCEOBorn	247	1952	1997	1979.81 (9.29)	–	–	–
IsOutProvCap	259	0	1	0.23 (0.42)	–	–	–
IsInWarsaw	259	0	1	0.36 (0.48)	–	–	–
Goal (PLN)	259	50 000.00	5 000 000.00	2 045 405.68 (1 386 981.74)	999 996.00	1 999 964.50	3 000 034.25
Year	259	2012	2022	2 020.01 (1.74)	2020	2021	2021
LegalForm	258	1	5	2.39 (0.89)	2	2	2
IssuePrice (PLN)	203	0.23	75 000.00	1 017.44 (5 747.24)	6.04	28.80	102.50
BoardMembers	259	0	5	1.53 (0.76)	1	1	2

Source: own study based on a database by Trzebiński, Wrocław University of Economics, Poland, https://airtable.com/shrXxy1MnmVD3hFuo/tblCtdOZ7FNdfdCI9/viwIMdWZAeI7ZdHPW?backgroundColor=green (DOA 10 May 2023).

We first subjected variables describing the success of the equity-based crowdfunding offer and success factors to a simple analysis to identify potential intra-group and inter-group correlation relationships. In the first group of variables, a relatively strong correlation between the various measures of success, showing a fairly consistent picture of the categories included in this set. Non-significant correlations were most common for the *FundedToEquity* and *Investors* index. The first observation indicated that an offer's success, understood as collecting expected capital, does not depend on the issuer's size. In contrast, the second indicates that this success is also not determined by many investors responding to the offer. Regarding success factors, the analysis revealed weak and mostly statistically insignificant relationships between factors. With these results variables describing issuers can be considered as independent.

An ANOVA analysis used selected variables describing success factors as grouping variables to verify the hypotheses. Although the analysed campaign database consisted of all data-covered 259 cases from 2012-2022 and could be considered a large sample (>30 observations), it did not yet allow for deeper subgroup analyses. However, comparisons of ECF campaign results for groups differing in inclusivity parameters were possible with ANOVA and t-tests. The distributions of the factors analysed were independent, the sample was large and the distributions of the means did not deviate far from a normal distribution, regardless of the shape of the population distribution (Central Limit Theorem). With this assumption, the results of statistical tests, such as ANOVA or t-test, become robust to deviations from normality. Moreover, we tested the assumption of homogeneity of variance with Levene's test. We then estimated Linear and logistic regression models to explain the joint impact of variables.

For discrete variables, we compared measures of success between groups of observations with and without attributes suspected to be a factor of success. For continuous variables, we compared measures of success between groups with factors observed below and above the median value. For the *LegalForm* variable, we compared the two main forms in which entities pursued issuance: joint-stock company (N=201) and limited liability company (N=41) representing 93.4% of observations. We performed the analysis using IBM SPSS software.

RESULTS AND DISCUSSION

An analysis of correlational interdependencies between measures of success of ECF offers and potential factors of success tentatively identified several key parameters that were relatively weak but statistically significantly related to measures of the success of the offer. These included the goals of the offer (*Goal*, negative relationship prevails), legal form of the issuer (*LegalForm*, positive relationship prevails), year of organization of the issue (*Year*, negative relationship prevails), and issue price (*IssuePrice*, positive relationship prevails). There may be potential relationships between issue success and location. However, we did not find any correlations in the area of inclusivity in terms of gender and age of TMT. We also discovered the negative relationship between measures of success and the presence of the shareholders' family on the issuer's management board.

For all ECF cases analysed, the average goal of the offer (*Goal*) was PLN 2 045 406 and allowed collecting an average of PLN 1 150 632 in a single offer (*Funded*), which resulted in a success rate (*SuccessRate*) of 64.26%. The collected capital allowed the average issuer to increase its equity more than a dozen times (the average *FundedToEquity* ratio was 12.87) and attracted 368 investors on average (*Investors*). If collecting at least the target capital was considered successful, 37% of cases can be considered successful (*IsSuccess100*). Moreover, 42% of issuers collected at least 80% of the goal, while 60% of the goal was collected in just over half of cases.

Gender

The presence of women either on the management board, serving as a CEO, or participating in the issuer's supervisory bodies was associated with setting a lower financial goal for the offer. The difference was statistically significant for issuers with a woman as a chairman (difference PLN 456 245; p-value = 0.05). A lower financial target was followed by a lower value of funds raised in an issue, the difference was statistically significant when a woman was present on the company's board (difference: PLN 331 587; p-value = 0.015) and when a woman served as a CEO (difference: PLN 349,831; p-value = 0.015). These results were consistent with the findings of Geiger and Oranburg (2018), Andrieu *et al.* (2021), and Cumming *et al.* (2021).

The difference in goals disappeared when we considered only the supervisory board. For other measures of ECF success, we found no statistical differences from the perspective of the presence of women in management or supervisory bodies. However, there was a significant positive effect of a female CEO on the success rate of an offer. Although the differences were not statistically significant, they were associated with a higher success rate, a higher ratio of issue proceeds to equity, and a higher chance of meeting the target at the 100%, 80%, and 60% threshold of the issue target. This result relates to the findings of Figueroa-Armijos, Berns (2022), and Zhao *et al.* (2021).

The presence of women on management boards (non-statistically) was associated with the opposite situation and hurt the effectiveness of the equity-based crowdfunding offer. In every case, the number of investors interested in an offer was lower when a woman served on the management board. Thus, apart from the cases indicated, there was no reason to believe that issuers who were gender inclusive would be more successful in ECF. In this case, the conclusion differs from the one presented in research by Cicchiello *et al.* (2021a).

Age

An analysis of the parameters of ECF offerings grouped by CEO age showed no deviation for younger (under 30, *IsCEOun30*) or older (over 60, *IsCEOov60*) executives. Although the success rate rose to 83.73%

for the youngest CEOs, while it dropped to 59.10% for the oldest, the differences compared to the other age groups were not statistically significant (p-value 0.071 and 0.356, respectively). A similar situation applies to other success measures. Thus, we did not confirm hypothesis H2: there is no evidence to reject the claim that the issuer's inclusiveness measured by the age of the CEO can affect the issue's success. Thus, the results for Poland did not support the relationship suggested by Cumming *et al.* (2021).

Location

It would seem that the fintech development reduces the importance of location in financial inclusion, and crowdfunding would ease access to funds for ventures outside the economic centre. However, our results regarding location were not entirely consistent with previous ones from the Brazilian market (Figueiredo & Bendelá, 2024) or Germany (Wang & Prokop, 2025). Poland's economic and business centre is its capital, and indeed, the vast majority of projects were placed by ventures with headquarters in Warsaw (64%). However, the provincial ventures were more successful. Indeed, we found significant statistical differences in the financial goal of the offer (*Goal*), the funds collected (*Funded*), the ratio of the funds collected to equity (*FundedToEquity*), and the number of interested investors (*Investors)*. Issuers whose headquarters were located outside regional capitals rather than in capitals set the highest financial goals (higher by PLN 755 274; p-value < 0.001), while issuers based in Warsaw set the lowest (lower than those outside Warsaw by PLN 509 123; p-value = 0.002). Since the success rates were similar, ranging between 64.01% and 64.75% depending on the location, the lower targets yielded a similar effect for the amounts collected in an offer. For entities located outside regional capitals, the average amount collected from equity-based crowdfunding was PLN 1 568 985 (p-value = 0.006), and for those located in Warsaw, it was the lowest, averaging PLN 865 512 (p-value < 0.001). Offers by issuers from outside of Warsaw also attracted a greater number of investors (an average of 450 versus 210 for Warsaw-based entities; p-value = 0.009), while entities outside of regional capitals attracted larger capital amounts in relation to their equity (16.32 times versus 11.77 times for the others; p-value = 0.001). Other measures of success were not statistically different between groups of entities by location. Given the indicated differences, we can assume that the location of the issuer can affect the success of ECF offers, and there is no evidence for rejecting hypothesis H3. Thus, the studied ECF offers bore the characteristics of inclusiveness due to the headquarters location and successful financing of entities from smaller centres. The results are related to the observations of Roma *et al.* (2017) and Zhao *et al.* (2021). Rostamkalaei and Freel (2023) focused on the geography of ECF supply but did not provide specific comparisons of campaign success based on issuer location in any country. They emphasize spatial influences on crowdfunding investment without confirming or contradicting our findings. Giudici *et al.* (2018) explain in their paper that geography influences crowdfunding success, showing that local altruism enhances project success, particularly in areas with strong social relations. However, it does not explicitly address ECF or compare results across different countries. In our study, we did not analyse the investor side. We may explore this theme in subsequent research involving investors who participate in ECF campaigns and declare to what extent sentiment towards local entities may influence their involvement in a project.

Regression Models

In the next step, we estimated linear regression models for continuous variables describing issue success (*Funded*, *SuccessRate,* and *FundedToEquity*) and logistic regression models for the dichotomous variable *IsSuccess100*. For each dependent variable, we estimated models based on all factors identified as potential success factors (Model 1A, 2A, 3A, and 4A respectively) as well as selected factors in a significant relationship with the success rate (Models 1S, 2S, 3S, and 4S respectively). We used logarithms of the offer financial goal (*Goal*) and collected financing (*Funded*) due to their range of variability compared to other variables in the model.

All linear regression models were statistically significant. Models of the collected capital confirmed a statistically significant negative impact on women's membership in the management board however a positive impact of a woman serving as CEO. By this, gender factors of the inclusiveness of equity-based crowdfunding proved to be significant. While these results may seem contradictory, they are also evi-

dence of the positive effect of inclusivity. The mere participation of women on the board, especially when they are not acting as CEO, must have a strong negative effect on the effectiveness of the offer, since it is neutralized by the positive effect of the female CEO. From this perspective, if gender inclusivity in a business project were to be used in ECF, the best solution is to have a woman acting as CEO, rather than just providing seats for women on a company's board managed by a male CEO.

Moreover, higher financial crowdfunding targets allow for a statistically higher nominal amount of capital collected. Furthermore, when the number of variables is reduced in the model, the positive effect of the legal form of the issuer, organized as a limited liability company, remains evident. In the models explaining the *SuccessRate* variable, setting a higher financial target (which is more difficult to achieve) had a negative effect. However, offering new shares by the limited liability company (preferred by investors as cost-effective to the joint-stock company) had a positive effect. In both models of the *FundedToEquity* variable, the inclusiveness parameter, related to the location of the issuer's headquarters outside the regional capital, turned out to be statistically significant. It had a positive effect on the studied variable (Table 4).

Table 4. Regression models: Factors of success in equity-based crowdfunding offers

Variables	Model 1A	Model 1S	Model 2A	Model 2S	Model 3A	Model 3S
	All	Selected	All	Selected	All	Selected
Dependent	Log(Funded)	Log(Funded)	SuccessRate	SuccessRate	FundedToEquity	FundedToEquity
Const	0.855 (.0.654)	0.677 (0.644)	2.399 *** (0.519)	2.291 *** (0.504)	-6.615 (9.591)	-14.729 (8.311)
IsFemBoard	-0.428 ** (0.152)	-0.327 * (0.143)	-0.209 (0.121)	–	-1.914 (2.000)	–
IsFemCEO	0.543 ** (0.188)	0.422 * (0.179)	0.245 (0.149)	–	4.951 * (2.470)	3.679 * (1.625)
IsOutProvCap	0.059 (0.098)	–	0.087 (0.078)	–	4.636 *** (1.367)	3.870 ** (1.266)
IsInWarsaw	-0.065 (0.086)	–	-0.041 (0.068)	–	1.311 (1.208)	–
Log(Goal)	0.731 *** (0.100)	0.799 *** (0.097)	-0.340 *** (0.079)	-0.313 *** (0.076)	2.967 * (1.475)	3.982 ** (1.370)
LegalForm	0.100 * (0.044)	0.106 * (0.044)	0.121 *** (0.035)	0.117 *** (0.035)	-1.246 (1.475)	–
Board4mbers	0.096 (0.053)	–	0.037 (0.042)	–	1.523 * (0.760)	1.038 (0.700)
F-test	10.535 ***	17.085 ***	6.607 ***	20.468 ***	5.208 ***	7.692 ***
Observations	249	252	250	255	186	190
R-squared	0.228	0.213	0.156	0.138	0.164	0.139
Adj. R-squared	0.207	0.201	0.132	0.132	0.132	0.121

Notes: Robust standard errors in parentheses. ***, ** and * indicates statistical significance at the 0.1%, 1%, and 5%, respectively.

Source: own study based on a database by Trzebiński, Wrocław University of Economics, Poland, https://airtable.com/shrXxy1MnmVD3hFuo/tblCtdOZ7FNdfdCI9/viwIMdWZAeI7ZdHPW?backgroundColor=green (DOA 10 May 2023).

Logistic regression models explained 11.9-14.2% of the variance of the dependent variable. In both models, the inclusivity factors of an issuer were statistically insignificant. The value of the equity offer and the legal form of the issuer explained the odds of crowdfunding success. Both models similarly showed that a 10-fold increase in the offer value reduced the odds of the offer success by over 63%. In contrast, operating as a limited liability company increased the odds of success by 1.5-1.6 times compared to a joint-stock company (Table 5). Therefore, the results were consistent with those presented earlier for linear regression models.

The literature analysis and previous research on ECF success and gender-related obstacles and benefits did not give unequivocal results. The previous study collected from the population of US ECF campaigns showed that campaigns receive significantly less funding when the primary signatory was

female. Moreover, campaigns raised significantly less funding, as the target amount increased, when the primary signatory was female (Geiger & Oranburg, 2018), or in other cases, there were no significant gender effects (Wang *et al.*, 2023b; Chuang *et al.*, 2025). Thus, studies on ECF in the USA (Geiger & Oranburg, 2018), France (Andrieu *et al.*, 2021) or the UK (Cumming *et al.,* 2021) suggest that crowdfunding does not ease the handicap of women in raising funds to create startups. Our research was consistent with the results of these scientific works. Unlike studies of Figueroa-Armijos and Berns (2022), Zhao *et al.* (2021), and Cicchiello *et al.* (2021a), which support the thesis that women do not set lower funding goals than men, and they have higher rates of success than men, which in turn is in line with our results regarding the success rate of crowdfunding campaigns.

Table 5. Logistic regression models: chances of success in equity-based crowdfunding offers

Variables	Model 4A			Model 4S		
	All			Selected		
Dependent	IsSuccess100			IsSuccess100		
	B	Wald	Exp(B)	B	Wald	Exp(B)
Const	5.042 * (2.451)	4.234	154.854	4.439 (2.312)	3.686	84.728
IsFemBoard	-0.717 (0.604)	1.407	.488	–	–	–
IsFemCEO	0.935 (0.727)	1.653	2.548	–	–	–
IsOutProvCap	0.447 (0.359)	1.555	1.546	–	–	–
IsInWarsaw	-0.164 (0.321)	0.261	0.849	–	–	–
Log(Goal)	-1.079 * (0.380)	8.059	0.340	-0.981 ** (0.356)	7.583	0.375
LegalForm	0.492 ** (0.159)	9.636	1.636	0.445 ** (0.154)	8.338	1.561
BoardMembers	-0.085 (0.191)	0.197	0.919	–	–	–
-2 Log-Likelihood	–	312.172	–	–	316.958	–
Observations	–	242	–	–	242	–
Correctly classified	–	70.9%	–	–	71.3%	–
Nagelkerke R-squared	–	0.142	–	–	0.119	–

Notes: Robust standard errors in parentheses. ***, ** and * indicates statistical significance at the 0.1%, 1% and 5%, respectively.

Source: own study based on a database by Trzebiński, Wrocław University of Economics, Poland, https://airtable.com/shrXxy1MnmVD3hFuo/tblCtdOZ7FNdfdCI9/viwIMdWZAeI7ZdHPW?backgroundColor=green (DOA 10 May 2023).

There are quite a few studies regarding the TMT age. In our study, age did not have a meaningful impact. The sample may be too small to show the relation. Alternatively, Polish people over 60 years old were not very involved in economic activity or unfamiliar with modern financial sources. The technological progress, the fintech development, on the one hand, supports the financial inclusion of people (especially those living in the province or poorer), but on the other makes it somewhat difficult for older people unfamiliar with modern applications.

Financial and economic centres, which are mostly the capitals of the countries, have the highest intellectual and social capital. Therefore, it is not surprising that most of the studied campaigns were started by companies in Warsaw. However, the success factors are higher for companies located outside the capital. On the one hand, the online platform seems to eliminate most distance-related hurdles, on the other hand, it does not eliminate social-related frictions (Agrawal *et al.*, 2010). We may associate this, for example, with the greater integrity of local communities and creates interesting study fields. The impact of local communities and social capital may explain the results. Outside big

cities, there is less anonymity. This makes it easier to reach family and friends with information about the project. It is also easier to gain their favour due to the low competition from other local projects.

CONCLUSIONS

To our knowledge, the presented research is the first to empirically assess the potential of ECF in the financial inclusion of underrepresented categories of entrepreneurs in Poland. Our sample included all ECF campaigns, so the result shows the entire market perspective. Companies with inclusive attributes on ECF platforms are in the minority in Poland. Nevertheless, we would be inclined to say consistent with Mollick and Robb (2016) that crowdfunding to some extent 'can help take the democratization of innovation, entrepreneurship(…) By giving a voice to people who would otherwise never even have a chance to seek funding, let alone provide it, crowdfunding creates opportunities for new businesses and innovations, as well as a new wave of investors.'

Most of the surveyed entities were characterized by a lack of inclusive attributes. The dominant part of entities founded by ECF are companies located in Warsaw or the capitals of voivodships, managed by men between the ages of 31-59. These results may contribute to the literature on ECF and female entrepreneurship, young, and silver entrepreneurship, and the link between ECF and financial inclusion.

Our research is not free from limitations. First of all, this study relies on data collected in Poland, an ethnically homogeneous country, so we excluded nationality or ethnical background from the inclusivity attributes. Therefore, we focused on other features of entrepreneurs. However, we may apply this approach in other countries, at least from the Central and East Europe regions, which are generally ethnically homogeneous. The other factors are universal. Secondly, it would be valuable to study only the age, as it was the least studied. Due to the sample size, we did not do that. Thirdly, even if it covers the whole sample of ECF issues available for the study period, the sample itself is not large enough to compare all interesting subgroups *e.g.*, sectoral differentiation, which may build a good direction in further research. Furthermore, the interesting differences in the effects of crowdfunding campaigns depending on the issuer's location could not be explained by the data we used. However, other cited studies indicate that investor sentiment towards local actors and products may explain these differences. Extending the study to analyse the motivations and behaviour of the demand side (investors) would show the process from a broader perspective and could explain the effects we discovered.

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The contribution share of authors is equal and amounted to 50% for each of them. DK – concepts, design, literature writing, data collection, discussion MK – design, methodology, interpretation of data, discussion.

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Acknowledgements and Financial Disclosure

This article was financially supported in equal parts by the Institute of Economics and Finance, University of Szczecin and the Institute of Economics and Finance, University of Maria Curie-Skłodowska in Lublin. The authors would like to thank the anonymous referees for their useful comments, which allowed to increase the value of this article.

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International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.08

Barriers to the foreign expansion of small and medium enterprises: Example of Subcarpathian exporters

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ABSTRACT

Objective: The article aims to present determinants of the activity of the small and medium enterprises (SME) sector. Moreover, we attempted to identify barriers to the internationalisation process and the degree of perceived difficulties in Subcarpathian SMEs. Economic literature devotes a lot of space to enterprises' internationalisation processes. Numerous theories and their empirical verifications explain this process by analysing the activities of large transnational corporations. The emergence of a global competitive environment has resulted in micro, small and medium-sized enterprises (SMEs) being involved in the internationalisation process.

Research Design & Methods: In addition to the classic literature analysis, we utilized a survey of internationalized enterprises operating in the Subcarpathian region. We attempted to identify external and internal barriers to internationalisation in SME enterprises. We evaluated differences in the perception of difficulties associated with the existence of individual obstacles in groups of enterprises separated by their size using the non-parametric Kruskal-Wallis test.

Findings: The article presents the determinants of the activity of the SME sector in the economic process or their export activity. Research confirms that SME enterprises in Poland, as a rule, are characterized by low resource potential, which causes them to conduct foreign expansion in less advanced forms, mainly in the form of internationalisation of the sphere of exchange.

Implications & Recommendations: The research indicates the main internal and external barriers perceived by Subcarpathian exporters. At the same time, they confirm the thesis that SME foreign expansion is mainly conducted in the form of exports. SME companies, often having limited resources while being creative and innovative, choose this very form, which gives them opportunities not only to enter a foreign market and gain experience but also to gain new contacts, learn about the requirements of the target market's customers or become familiar with international business.

Contribution & Value Added: It is essential to indicate whether they conduct the internationalisation process similarly or perceive the same barriers to entry into the foreign market. The variety of forms of the internationalisation process and the many factors determining it, create great research opportunities. Still, they are associated with difficulties in inference and give rise to the danger of using simplifications or generalisations.

Article type: research article

Keywords: internationalisation; export; barrier; enterprise; SME sector

JEL codes: D25, F20, F21, F23

Received: 15 November 2024 Revised: 13 March 2025 Accepted: 26 March 2025

Suggested citation:

Puchalska, K., Majka, A., & Żegleń, P. (2025). Barriers to the foreign expansion of small and medium enterprises: Example of Subcarpathian exporters. *International Entrepreneurship Review,* 11(3), 179-192. https://doi.org/10.15678/IER.2025.1103.08

INTRODUCTION

Companies' internationalisation is a complex and multifaceted process that varies according to company size, industry, geographic origin, and many other factors. Theoretical and empirical studies provide valuable insights into the motivations, strategies, and challenges of internationalisation (Jones & Coviello, 2005; Narayanan, 2016; Wach *et al.*, 2018; Du *et al.*, 2023; Domínguez Romero *et al.*, 2024).

Moreover, SME companies that actively participate in the internationalisation process are an essential part of today's economy. Among them, exporters are an important group. Noteworthy, 99% of European businesses are SMEs. They provide jobs to more than 85 million European citizens and are at the heart of innovation and entrepreneurship. The ideas and solutions of 24.3 million women and men entrepreneurs contribute to a sustainable and digital economy central to Europe's competitiveness (https://single-market-economy.ec.europa.eu/smes_en dated July 24, 2024).

The study's objectives include: 1) introducing the term internationalisation, and 2) assessing the main internal and external barriers perceived by SME exporters.

We tried to find answers to the following research questions:

- How do exporters from the Subcarpathian region feel the various barriers to the internationalisation process?
- Which of the barriers to internationalisation are the most burdensome (difficult to overcome)?
- Does the degree of perception of barriers correlate with the size of the company?

We formulated the following research hypotheses:

- Subcarpathian exporters are much more strongly affected by the external barriers of the internationalisation process;
- The main barrier to foreign market entry of the analysed entities is the state's fiscal policy and a high degree of bureaucracy;
- The degree of perception of barriers to the internationalisation process increases with the decrease in the size of the exporting company.

Increasing competition in foreign markets, the high demands of product buyers, and the spread of international standards force companies to constantly adapt to the changing environment. Internationalisation, or 'entering' foreign markets, often increasingly distant ones, is a process that takes place in many ways and is determined by several factors that provide great opportunities but simultaneously imply problems. Scholars define companies' internationalisation as a sequence in which companies become significantly aware of the direct and indirect impact of international transactions on their future and establish and conduct transactions as well as cooperation with entities from other countries (Duliniec, 2011; Virglerova *et al.*, 2021; Haley *et al.*, 2022).

As a process of adapting a company's activities (strategy, structure, resources) to the international environment, internationalisation is also 'the foreign expansion of a company, which includes any type of economic activity undertaken by a company abroad or with foreign partners' (Rozkwitalska, 2007). It is a creative process of identifying and exploiting opportunities in foreign markets (Wach & Wehrmann, 2014).

Numerous questions usually accompany the internationalisation of small and medium-sized enterprises. The most common questions sought are what form of foreign market entry to choose (Dorozhinsky, 2014; Hofman-Kohlmeyer, 2018; Bołoz, 2019), how to identify threats and barriers, and what type of advantages the entity must have.

Exporting, as a form of internationalisation, creates opportunities to initiate new activities in foreign markets. Export activities force entrepreneurs to adapt their offerings to the requirements and expectations of foreign markets, affecting the quality of the products/services offered and leading to an increase in business standards. In addition, by increasing the scale of production, export activity reduces unit costs, which can translate into increased profit, an improved competitive position, or both.

The article presents the barriers to foreign market entry of SME enterprises, among which are mainly considered the fiscal policy pursued and the high degree of bureaucracy in Poland. This problem is vital from the exporter's point of view because it determines the strategy for entering a foreign market. Identifying and eliminating barriers should be the basis of any export process. In turn, correct evaluation of these issues most often results in success in new foreign markets.

The study's added value lies in the identification and detailed analysis of barriers hindering the foreign expansion of small and medium-sized enterprises on the example of exporters from the Subcarpathian region. Moreover, the added value is perceived as placing the results in the context of ex-

isting research on the issues of internationalisation of SMEs and paying attention to the degree of difficulty noticed by entrepreneurs undertaking activities in foreign markets. The study provides practical insights into specific regional challenges, which can support the development of effective internationalisation strategies and policies to support SMEs in expanding into foreign markets. It also contributes to the existing literature and points the way for future research. Indeed, the analysis of the barriers indicates the need to adopt specific directions to support SME enterprises/exporters in several areas. These include, among others, support in obtaining capital, human resources, and legal services, resulting from the need to adapt to different legal tax regulations. This is a fundamental issue, as this problem is taken up by the European Commission and indicated in the EC's 2020 report (https://ec.europa.eu/docsroom/documents/44244 of 24.07.24.).

The article has the following structure. First, we introduced the essence of the internationalisation phenomenon among SME entrepreneurs in Subcarpathian Voivodeship. Next, we will present the source literature in an aspect of scientific theories concerning enterprises' internationalisation process. Subsequently, we will discuss the determinants of the SME sector's economic activity and the barriers to their activity. The article includes research results, discussion, and conclusions.

LITERATURE REVIEW

The internationalisation of SMEs is a complex area of research that considers the specific and unique challenges faced by small and medium-sized enterprises in entering foreign markets. Thanks to the contributions of many researchers (Al-Hyari *et al.*, 2012; Fernandes *et al.,* 2020; Urban *et al.*, 2023), it is possible to comprehensively understand the dynamics, strategies, and success factors in SME internationalisation.

The literature in management and economics devotes much attention to the companies' internationalisation processes (Ribeiro Cahen, 2016; Genc *et al.*, 2019; Ramdani *et al.*, 2023). Numerous theories, such as product life cycle theory according to Vernon (1966), Uppsala model according to Johanson and Vahlne (1977), export behaviour theory according to Leonidou and Katsikeas (1996), Porter's Diamond Model according to Porter (1990), SMEs internationalisation theory according to Johanson and Vahlne (2003) and others and their empirical verifications explain this process by analysing activities mainly through the lens of transnational corporations.

Researchers focus on various aspects of the process, including the motivations, strategies, challenges, and impacts of internationalisation.

Starting the literature review with the product life cycle theory (Vernon, 1966), we should note that according to this theory, products go through a life cycle that affects their internationalisation. As the product matures, production is shifted to lower-cost countries. The Uppsala model (Johanson & Vahlne, 1977) describes internationalisation as a gradual process in which companies expand into foreign markets, starting with those most culturally and geographically similar. Also noteworthy is the export behaviour theory (Leonidou & Katsikeas, 1996), in which the authors focus on companies' export decisions, analyzing export motivations, barriers, and strategies. Another theory in business internationalisation (network theory, according to Håkansson and Snehota (1989), emphasizes the importance of networks and relationships between companies in the internationalisation process, with relationships with foreign partners being crucial to success. On the other hand, the OLI paradigm (Dunning, 1988) suggests that companies choose to internationalize when they have proprietary advantages (*e.g.*, unique technologies), locational advantages (*e.g.*, favourable conditions in foreign markets), and internalization advantages (*e.g.*, benefits from control of operations abroad). Another theory supporting the internationalisation processes of companies is the transaction cost theory (Williamson, 1975), which assumes that companies make internationalisation decisions based on an analysis of the transaction costs associated with various forms of international activity. Another theory, the evolutionary theory (Nelson & Winter, 1982), treats internationalisation as an evolutionary process in which companies adapt to changing market conditions through innovation and acquiring new skills. On the other hand, Porter's diamond model (Porter, 1990) suggests that firms' international competitiveness depends on four main elements: factor conditions, demand conditions, affinity and supporting industries, and firms' strategy, structure, and rivalry. The last of

the cited theories of corporate internationalisation is the SME internationalisation theory (McDougall, 1994), which focuses on small and medium-sized enterprises' specific challenges and internationalisation strategies, especially so-called 'born globals,' i.e., globally oriented from the start (Moen, 2002; Øyna & Alon, 2018). The pioneers of research on 'born goals' were Knight and Cavusgil (1996), who showed that some companies are globally oriented from inception and develop international operations much faster than traditional internationalisation models suggest.

Furthermore, on a European scale, in 'The Phenomenon of Early Internationalizing Firms: What Do We Know After a Decade (1993-2003) of Scientific Inquiry?,' Rialp *et al.* (2005) analyze the internationalisation of small and medium-sized enterprises in the European context, noting the enabling factors and barriers. In the context of studies conducted in so-called 'emerging markets,' cite Luo and Tung's (2007) work, 'International Expansion of Emerging Markets. International Expansion of Emerging Market Enterprises: A Springboard Perspective,' in which the research focuses on companies in emerging markets and their strategies for using internationalisation as a springboard for acquiring resources and technology.

Noteworthy, researchers' approaches to internationalisation have been changing in response to changes in global economies' (Daszkiewicz & Wach, 2014). Wach made, among other things, a detailed study of models in the internationalisation of small and medium-sized enterprises, also pointing out their contemporary forms.

As numerous studies indicate (Costa *et al*., 2018; Costa *et al*., 2022; Love & Roper, 2015; Brambil-la *et al*., 2012), these companies face many barriers and risks in the process of internationalisation. Costa *et al*. (2023) indicate the following types of barriers: external, strategic management, net-working, and operation. Important reflections on the barriers that occur on the way of the compa-ny's development were presented by Leonidou (1995), who described the barriers by identifying them with internationalisation through export. These barriers include structural, operational, and other barriers that limit the company from undertaking or developing internationalisation. Nowakowski (1999) identified and classified barriers in the internationalisation process. He divided them into: internal, which included, among others: quantitative and qualitative limitations in the sphere of human, material and financial resources, improper approach or lack of skills in the field of the strategy of operating on the markets, psychological resistance or fear of risk, or an overly opti-mistic assessment of the chance of entering a foreign market as well as external barriers, such as lack of support (or insufficient support) from national authorities and institutions, the so-called negative protection, state security considerations and restrictions related to international agree-ments. Particularly valuable in this regard seems to be the research of Nurfarida *et al*. (2022) who conducted a literature review to identify important research findings on the motives and barriers hindering the internationalisation of SMEs over a period of 10 years.

As the literature review shows, the internationalisation of enterprises is a long-term and complex process, depending on economic, social, cultural, political, geographic conditions, etc. There is always research on its course, essence, and significance for the national, European, and global economy. The following part of the article will present the determinants of the internationalisation process of SMEs in Poland and its impact on the functioning of these enterprises.

For most high developed economies, the micro, small and medium-sized enterprise (SME) sector is the most critical pillar of their development (Pietrasieński & Ślusarczyk, 2015). In Poland, this phenomenon is illustrated by the total number of business entities. Of the 2.3 million non-financial enterprises operating in Poland in 2022, as many as 99.8% of entities belonged to the SME group, of which as many as 97.2% were microenterprises (https://www.politykainsight.pl/prawo/_resource/multimedium/20306210 as of July 2024).

Establishing a microenterprise is much simpler than developing a large company, but this does not change the fact that the steadily increasing share of microenterprises in the total number of business entities shows their importance to the economy. This importance is also confirmed by data on the SME sector's contribution to GDP. According to PARP (2023), the SME sector in Poland generates nearly three-quarters of the GDP value (71.6%). Microenterprises have the largest share of GDP creation – about 29.5%, and the entire SME sector generated 43.6% of GDP (data for 2020).

Table 1. Number of non-financial enterprises in Poland by number of employees in 2019-2022

Years	Number of enterprises	Number of people working			
	Total	up to 9 people	10-49	50-249	250 or more people
2022	2 349 755	2 283 379	48 217	14 341	3 818
2021	2 355 980	2 288 844	48 731	14 618	3 787
2020	2 261 856	2 194 244	49 514	14 433	3 665
2019	2 211 604	2 144 162	48 911	14 780	3 751

Source: CSO data, Non-financial enterprises by type and place of business in 2019, 2020, 2021, 2022 (as of July 24, 2024).

Establishing a microenterprise is much simpler than developing a large company, but this does not change the fact that the steadily increasing share of microenterprises in the total number of business entities shows their importance to the economy. This importance is also confirmed by data on the SME sector's contribution to GDP. According to PARP (2023), the SME sector in Poland generates nearly three-quarters of the GDP value (71.6%). Microenterprises have the largest share of GDP creation – about 29.5%, and the entire SME sector generated 43.6% of GDP (data for 2020).

The internationalisation process of the Polish economy is proceeding dynamically. The ratio of exports of goods and services to GDP is steadily increasing. It increased by 17.9 p.p. between 2012 and 2022. Since 2016, the ratio of exports to GDP has exceeded 50%, and Polish companies are increasingly engaged in satisfying the demand of foreign consumers rather than Polish ones. The same is true of imports.

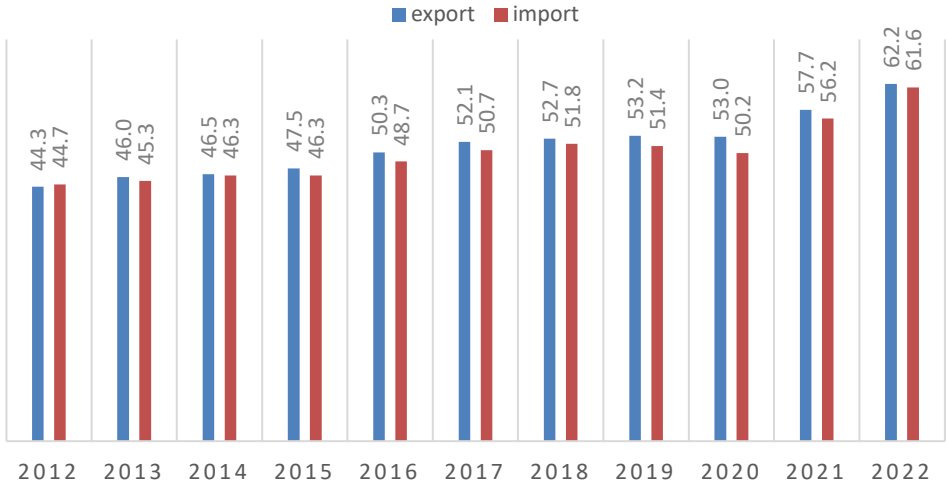

Figure 1. The ratio of exports to GDP and the ratio of imports to domestic demand from 2012 to 2022
Source: own elaboration based on CSO data from the publication Annual Macroeconomic Indicators (dated 24.07.24).

One of the primary measures of the internationalisation of the economy is the number of companies engaged in exporting or importing. Unfortunately, this area is still not one of the strengths of our economy. Based on CSO data for 2021, PARP estimates show that 4.5% of companies in Poland (*i.e.*, 106.4 thousand) sell products abroad, and only 0.97% (20.5 thousand) sell services.

Polish companies generate a relatively large percentage of their revenue from exports. According to estimates based on CSO data, in 2021. 25.8% of companies' revenues came from exports of products and services. The weakest performance in this regard was achieved by micro companies (5.9%), clearly better by small (17.0%), medium (20.9%) and large entities (27.0%). Over the 2012-2021 period, a steady increase can be seen in the internationalisation of enterprises' activities, as measured by the percentage of exports of products and services in total revenues of enterprises. During this period, the share of exports in the revenues of Polish enterprises grew steadily (from 2012 to 2021, an increase of 6.5 p.p.).

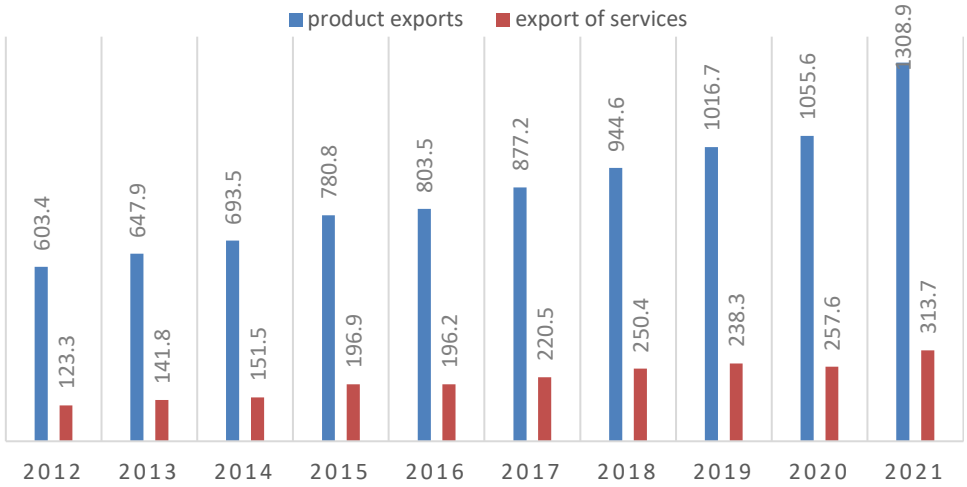

Figure 2. Value of exports from 2012 to 2021 in billion PLN
Source: https://www.parp.gov.pl/storage/publications/pdf/ROSS_2023_scalony_ost_akt.pdf. (dated July 24, 24).

RESEARCH METHODOLOGY

The results presented here are part of a broader study conducted among SME enterprises with foreign capital from the Subcarpathian region. This research was conducted in 2019.

The research was conducted based on a questionnaire addressed to all enterprises with foreign capital from the Subcarpathian region (696 enterprises) – 194 companies responded to the survey. One can assess the degree of company internationalisation using various measures, a significant number of which have a quantitative dimension. As emphasized by McDougall *et al.* (1994) and Duliniec (2011), an indicator calculated as the share of exports (or profit made from them) in the total sales (respectively: in total profit) of a company seems to be of the most significant importance in analyses. Therefore, for this study, we based the analysis on data from companies where the share of exports in the value of production sold exceeded 20%.

We analysed data from 70 enterprises, with small and medium-sized enterprises accounting for 41.4% each and micro-enterprises accounting for 17.2%. Table 2 shows the detailed structure of the studied collective.

Among the surveyed enterprises, the dominant ones were those that have been operating for more than ten years – they accounted for 60% of the surveyed collective, while the relatively most minor share (2.8% of the total surveyed) was held by young companies – operating for 1 to 2 years. Manufacturing and service industry companies were the most numerous, which accounted for 37.2% and 34.3% of the total surveyed, respectively.

The scope of the research concerned the forms of expansion and planned strategies of enterprises in foreign markets. Among other things, we asked entrepreneurs what barriers to internationalisation they identified and the perceived degree of threat of this problem. Barriers to internationalisation (both internal and external) were assessed based on a survey interview, in which the respondents assigned ratings on a scale from 0 (when the barrier did not occur) to 4 (when it happened to a very high degree). For this study, we analysed data from companies where the share of exports in the value of production sold exceeded 20%. We conducted a Kruskal-Wallis test to examine the differences in the perception of difficulties associated with the occurrence of individual (internal and external) barriers to the internationalisation process in different groups of companies separated by their size. Using this test, we evaluated whether *n* independent populations came from the same population (or a population with the same median) (Jóźwiak & Podgórski, 2006). In this study, we verified the zero hypothesis, according to which the degree of perceived barriers does not depend on the size of the enterprise, *i.e.*, the distributions of the degree of perceived barriers are the same for different groups of the size of the enterprise.

Table 2. Structure of the study population

Specification		Number of enterprises	Percentage of companies
Enterprise size by employment	1-9 people	12	17.2%
	10-49 people	29	41.4%
	50-249 people	29	41.4%
Total		70	100%
Period of operation of the company in years	1-2 years	2	2.8%
	3-4 years	6	8.6%
	5-6 years	4	5.7%
	7-8 years	6	8.6%
	9-10 years	10	14.3%
	over ten years	42	60.0%
Total		70	100%
Main sector of activity	trading	19	27.1%
	services	24	34.3%
	processing industry	26	37.2%
	extractive industry	1	1.4%
	Total:	70	100%

Source: own study based on own survey data.

If there was a statistically significant difference ($p < 0.05$) between groups, the next step involved multiple comparisons for pairs of subgroups (Koronacki & Mielniczuk, 2006), presenting (in tabular form) the test probability value only for groups that differed significantly. We performed all calculations using the *Statistica 13* package.

RESULTS AND DISCUSSION

The research shows that, as a rule, SME enterprises in Poland display low resource potential, which causes them to expand abroad in less advanced forms, mainly in the form of internationalisation of the sphere of exchange. The surveyed enterprises confirm the thesis. A common practice of most companies in the Subcarpathian region is to import and export in parallel. Direct export was most often indicated as the dominant form of expansion of the SME sector (29.4% of enterprises), with this form being the leading one in every third of small and medium-sized companies and every fifth microenterprise. The research conducted – as well as the study of many other researchers (Golębiowski, 2007; Witek-Hajduk, 2007; Plawgo, 2004; Domanska, 2016) – confirms the thesis that SME foreign expansion is mainly conducted in the form of exports. SME companies, often having limited resources while being creative and innovative, choose this very form, which gives them opportunities not only to enter a foreign market and gain experience but also to gain new contacts, learn about the requirements of the target market's customers or become familiar with international business.

The ordering of internal barriers to internationalisation according to the strength of the problem for exporters in the SME sector in the Subcarpathian region is as follows:

- resistance and fear of risk (strength of problem 1.7),
- quantitative and qualitative limitation of human, material, and financial resources (strength of the problem 1.7),
- inappropriate approach or lack of skills in the field of strategy for operating in foreign markets (strength of problem 1.5),
- overly optimistic assessment of the chances of entering the market (strength of the problem 1.3).

As many as 90% of Subcarpathian SME enterprises declared the occurrence of difficulties related to the quantitative and qualitative limitation of human, material, and financial resources when entering a new sector/industry (Table 3), with 70% of the surveyed companies considering that these difficulties occurred to a 'very low or medium' degree. Although the degree of perceived difficulty experi-

enced in connection with this barrier was noticeably higher in the surveyed micro companies than in small and medium-sized enterprises (Figure 1, Table 3), the difference proved statistically insignificant.

Table 3. Internal barriers to internationalisation observed when a company enters a particular sector/industry (percentage of companies surveyed)

Barriers and difficulties	Did not occur	They occurred at a very low rate	Occurred to a medium degree	They occurred at a high rate	They occurred at a very high rate	Average strength of the problem
Quantitative and qualitative limitations of human, material, and financial resources	10.0%	30.0%	40.0%	18.6%	1.4%	1.7
Inappropriate approach or lack of skills in the field of foreign market operations strategy	21.4%	28.6%	28.6%	18.6%	2.9%	1.5
Resistance, fear of risk	14.3%	31.4%	27.1%	22.9%	4.3%	1.7
Overly optimistic assessment of market entry opportunities	22.9%	35.7%	31.4%	8.6%	1.4%	1.3
Poor evaluation of market signals	22.9%	28.6%	35.7%	12.9%	0.0%	1.4

Source: own study based on own survey data.

An inadequate approach or lack of skills in foreign market strategy was a barrier in nearly 80% of the companies surveyed (Table 3). Among 57.6% of respondents, this difficulty occurred to a very low or medium degree, and 2.9% to a very high degree. A high or very high degree of difficulty associated with this barrier was noted by 27% of medium-sized, 7% of small, and 41% of micro-enterprises. Noteworthy, 28% of small and 24% of medium-sized enterprises did not experience such a barrier to entry.

Over 85% of Subcarpathian SME companies involved in exporting experienced difficulties related to resistance and fear of risk were. In total, 58% of the surveyed microenterprises, 21% of small, and 20% of medium-sized companies declared a high and very high degree of feeling this barrier. An overly optimistic assessment of the chances of market entry occurred in nearly 77% of the companies surveyed, with the vast majority (67.1%) believing that this barrier happened to a very low or medium degree.

Moreover, 77.1% of respondents declared difficulties related to poor evaluation of market signals. Similarly, as in the case of an overly optimistic assessment of market entry opportunities, they were predominantly of a very low or medium onerous nature (this level of occurrence of difficulties was indicated by 64.3% of companies). None of the surveyed exporters reported the occurrence of this barrier to internationalisation to a very high degree. The results of the Kruskal-Wallis test (Table 4) confirmed the existence of statistically significant differences only between the degree of perceived difficulties related to fear of risk, with these difficulties being significantly more strongly perceived by micro-enterprises than by small enterprises.

In turn, the ordering of external barriers to internationalisation according to the strength of the problem according to exporters in the SME sector in the Subcarpathian region is as follows:

- high taxes (strength of problem 2.4),
- bureaucracy and regulatory changes (strength of problem 2.2),
- lack of support or insufficient support from national authorities and institutions (strength of the problem 2.1),
- formal barriers to entry created by the state (strength of the problem 1.9),
- international treaty restrictions and unreliability of contractors (strength of problem 1.8),
- lack of accuracy in determining certification requirements (strength of problem 1.7).

Noteworthy, the degree of difficulty associated with the occurrence of individual problems (strength of the problem) is (according to respondents' indications) significantly higher for external barriers than for internal ones.

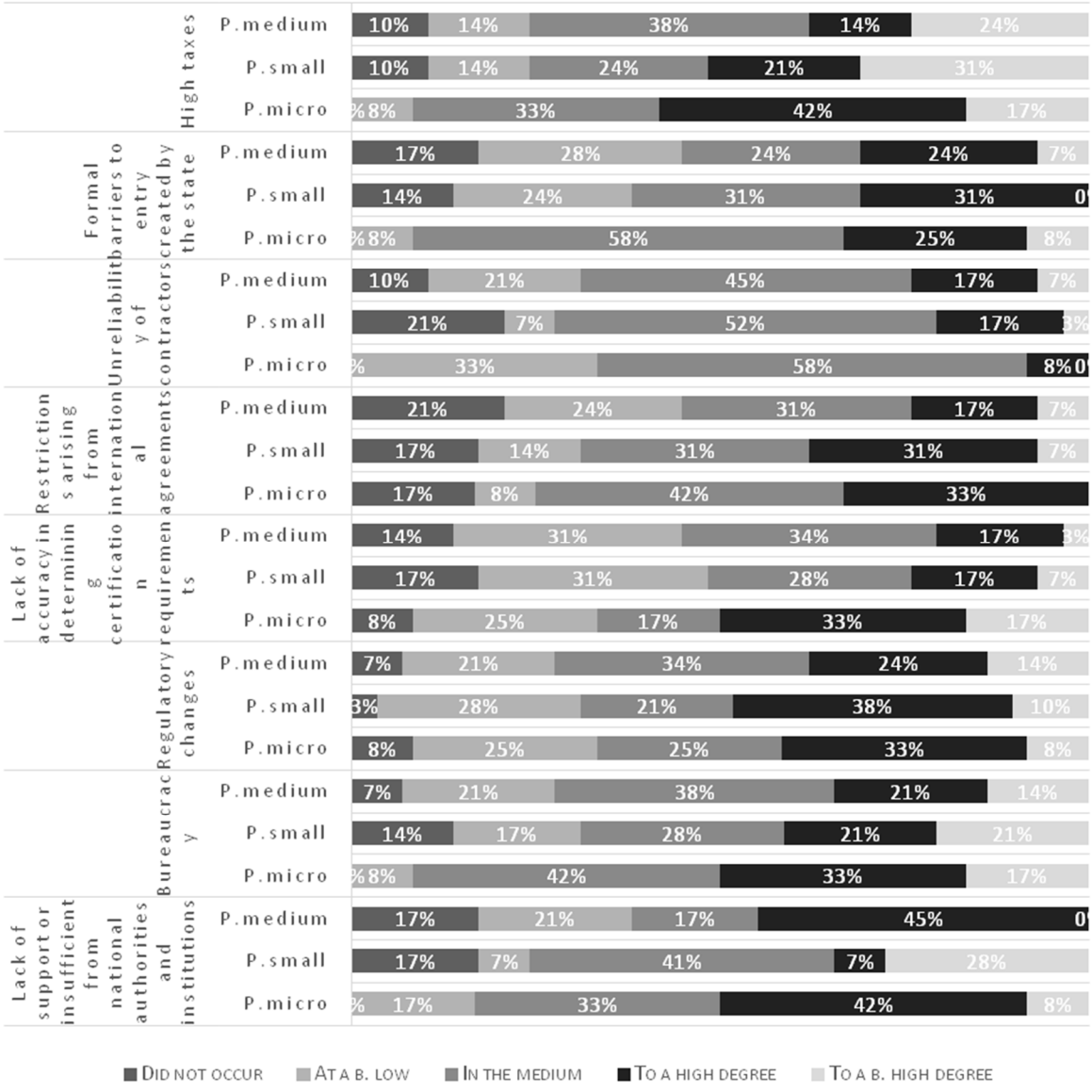

Figure 4. External barriers to internationalisation observed upon entry into a particular sector/industry in micro, small and medium enterprises

Source: : own elaboration based on survey data.

Table 6. Company size vs. perception of external barriers to internationalisation

Barriers and difficulties	Average strength of the problem			H^*	p^{**}
	P. micro	P. small	P. average		
Lack of support or insufficient from national authorities and institutions	2.42	2.21	1.90	1.310	0.519
Bureaucracy	2.58	2.17	2.14	1.315	0.518
Regulatory changes	2.08	2.24	2.17	0.162	0.922
Lack of accuracy in determining certification requirements	2.25	1.65	1.66	2.364	0.307
Restrictions arising from international agreements	1.92	1.96	1.66	1.335	0.513
Unreliability of contractors	1.75	1.76	1.90	0.306	0.858
Formal barriers to entry created by the state	2.33	1.79	1.76	2.32	0.313
High taxes	2.67	2.48	2.26	0.900	0.637

Source: own study based on self-reported survey data.

We conducted Kruskal-Wallis test to assess whether the size of an enterprise differentiates the perception of difficulties associated with the presence of particular external barriers to internationalisation (Figure 4). The test results showed no statistically significant differences in the perception of the difficulty of the external obstacles in micro, small, and medium-sized enterprises (Table 6).

CONCLUSIONS

As a general summary of results, we claim that the internationalisation process requires an in-depth analysis of internal and external barriers. These are undoubtedly important and often key issues in exporters' decision-making process. This publication assesses the role of SMEs as a pillar of economic development and attempts to identify internal and external barriers perceived by Subcarpathian exporters in the SME sector. The classification of perceptions of the internal obstacles at the time of a company's entry into a given sector/industry indicates that the vast majority of Subcarpathian SME companies identify difficulties related to the limitation of human, material, and financial resources, with 70% of the surveyed companies considering these difficulties to have occurred to a 'very low or medium' degree. Although the degree of perceived problems arising in connection with this barrier was noticeably higher in the surveyed micro-enterprises than in small and medium-sized enterprises, the difference was statistically insignificant. On the other hand, perceptual differentiation of external barriers to internationalisation points to insufficient support (or lack thereof) from domestic authorities and institutions as a barrier when entering foreign markets. Bureaucratic difficulties that arise in the internationalisation process are rated as highly burdensome. We also found that legal regulations are essential for the internationalisation decisions of the analysed entities.

Through the research and analysis of these studies, we can be deduce that the SME sector in Poland faces several impediments and barriers, inhibiting their expansion into foreign markets. Among the recommendations concerning the activities of this type of enterprise in foreign markets, it is necessary to propose, first of all, simplification of the legal regulations for starting operations abroad, as well as increased support (legislative, fiscal, administrative, and other) of domestic authorities and institutions for companies intending to start operations in a foreign market. Respondents also emphasized the need to study the market these companies intend to operate in. Market research should consist of an analysis of competing companies in the target market, as a lack of reliability of contractors was cited as a barrier to operating in foreign markets. An important role also belongs to learning about the preferences and needs of potential customers and investigating whether there is enough demand in the target market for the products/services offered by these companies. Moreover, respondents also assign importance to the marketing strategy adopted and logistical and distribution support in the foreign market.

We know that the research may indicate some limitations since we conducted it in a province with a low degree of industrialization. Nevertheless, it is a border province conducive to establishing international cooperation and undertaking economic initiatives in border markets (and beyond). As the main limitation of the research, we point to the fact that the survey covered enterprises that are already engaged in export activities, while as suggestions for future studies, we point out the need to conduct research among enterprises in the SME sector that have not yet decided to do business abroad. The survey could be supplemented by enterprises from outside the SME sector and other provinces (besides the Subcarpathian region) for comparative analysis.

Concerning empirical studies, it is worth noting that it is difficult to decide to what extent the indicated barriers are permanent here. We are aware that there are still many unanswered questions regarding the internationalization of SMEs in relation to the factors determining their growth. Hence, there is a need for ongoing monitoring of perceived barriers to internationalization. We believe that the existing assumptions about the business environment, as well as the relationships and linkages of international entrepreneurship, also require analysis.

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Acknowledgements and Financial Disclosure

Fundings provided by Faculty of Economics and Finance, University of Rzeszów, Poland.

Use of Artificial Intelligence

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Published by Krakow University of Economics – Krakow, Poland

International Entrepreneurship Review

2025, Vol. 11, No. 3

10.15678/IER.2025.1103.09

Globalisation and human development: Long-term evidence from countries at different levels of development

Dorota Kuder, Justyna Wróblewska

ABSTRACT

Objective: The main goal of this research is to assess the long-term effects of economic, social, and political globalisation on human development, as measured by the Human Development Index (HDI). The study also identifies how these relationships differ across groups of countries at different levels of development, using panel data econometric techniques.

Research Design & Methods: The research used a balanced panel dataset, which included 40 countries grouped by HDI development levels across 33 years (from 1990 to 2022). The KOF Globalisation Index captures globalisation through three dimensions: economic, social, and political. The HDI serves as the dependent variable, representing the quality of life. The research methodology uses log-linear panel cointegration models, which employ common correlated effects (CCE) estimators and include a panel error correction model (ECM) to analyse long-run relationship dynamics.

Findings: Social globalisation creates positive and substantial effects on HDI in countries at all development levels, including those with very high, medium, and low development, especially in countries with limited access to essential services. The effects of economic globalisation on different groups show no pattern of sustained change, and political globalisation benefits only high-HDI countries that possess strong institutional capacity. The research demonstrates that globalisation and HDI share a cointegration relationship, while developed countries exhibit both rapid adjustment and periodic patterns.

Implications & Recommendations: The research demonstrates that globalisation produces varying impacts on human development based on the development stage of a nation and its institutional capabilities. Developing nations need to build stronger institutions and social services to benefit from social globalisation, while economic integration demands domestic reforms that include all segments of society. Advanced countries need to stay actively involved in global politics while developing strategies that suit their individual national situations.

Contribution & Value Added: The research adds value to existing literature through its comprehensive evaluation of globalisation's multiple dimensions on human development, which examines economic, social, and political effects in different development stages. The econometric framework used in this study addresses cross-sectional dependence and heterogeneity while providing policy-relevant insights into the effects of globalisation on quality of life. A key novelty of this article lies in its differentiated analysis across HDI-based country groups, offering long-term evidence on how globalisation's effects vary depending on national development levels and institutional capacity.

Article type: research article

Keywords: Globalisation; human development; quality of life; panel data analysis; long-term effects

JEL codes: F63, I31

Received: 15 February 2025 Revised: 1 July 2025 Accepted: 20 August 2025

Suggested citation:

Kuder, D., & Wróblewska, J. (2025). Globalisation and human development: Long-term evidence from countries at different levels of development. *International Entrepreneurship Review,* 11(3), 193-210. https://doi.org/10.15678/IER.2025.1103.09

INTRODUCTION

During the early twenty-first century, globalisation developed into a complete transformative force which reshapes institutional structures and cultural foundations and political systems of nations world-

wide. The fast-growing cross-border movement of goods and capital and people and information and ideas has created extensive national interdependence, which transforms how countries develop (Gonzalez-Perez *et al.*, 2024). The increasing depth of globalisation requires a complete understanding of its effects, which extend beyond economic production to human wellness and life quality (Tamasauskiene & Žičkienė, 2021). Scholars extensively researched the economic aspects of globalisation, but the effects of economic, social, and political globalisation on human development continue to be an active area of scientific investigation (Cuyvers, 2001).

The studies by Sapkota (2011), Behera and Sahoo (2023), Figueroa (2014), Cieślik (2014), Ulucak *et al.* (2020), and Asongu (2012) share a common research focus on examining how different dimensions of globalisation influence human development or quality of life, particularly through the lens of the Human Development Index (HDI). They all employ quantitative methods (*e.g.*, panel data econometrics, cointegration, or ARDL models) and emphasise the heterogeneous impact of globalisation across countries at various stages of development or with varying institutional capacities. A recurring conclusion across these works is that the benefits of globalisation on HDI are not automatic, and are often mediated by domestic factors such as governance, education, ICT diffusion, and income inequality.

Our study contributes to an active and policy-relevant area of research by examining how different dimensions of globalisation – economic, social, and political – affect human development across varying levels of national development. Although globalisation has received wide scholarly attention, its nuanced long-term impact on human development remains underexplored, particularly in a post-pandemic world marked by growing global interdependence. By applying panel cointegration techniques, this article offers timely and original insights into how globalisation's effects differ across contexts and what this means for inclusive development strategies.

The human development index (HDI) offers a complete evaluation of societal advancement, which extends past traditional income-based assessments. The index shows advancements in health outcomes together with education levels and standard of living, which respond to policy decisions and institutional strength and external global influences.[1] The effects of globalisation on HDI occur through direct and indirect channels, which include international knowledge diffusion and global health initiatives and educational exchange and capital investments and institutional alignment with global norms. The effects of globalisation tend to vary substantially between nations that differ in their developmental stages. The integration of global markets offers developing nations access to modern technology and better healthcare, but simultaneously exposes them to economic instability and limited freedom in domestic policy decisions. High-income countries gain advantages from international political cooperation and social connections, yet experience decreasing returns from their economic integration activities.

This research aims to assess the long-term effects of economic, social, and political globalisation on human development, as measured by the Human Development Index (HDI). It also identifies how these relationships differ across groups of countries at different development levels, using panel data econometric techniques. The study utilised four balanced panel datasets covering a total of 40 countries (ten countries each with high and very high and medium and low HDI levels) from 1990 to 2022 (T=33, N=10 per group) to investigate long-term structural relationships and dynamic adjustments in HDI. The three components of the KOF Globalisation Index served as our main explanatory variables since they provide standardised economic, social, and political globalisation scores on a 0-100 scale.

Our analysis utilised a log-linear model that applies logarithmic transformations to HDI together with the three globalisation indices to determine long-run relationships. Analysis of the relationship between HDI and globalisation forms becomes easier through elasticity coefficients, which measure how percentage changes in globalisation affect HDI. To address global shocks which affect all panel members, we used the common correlated effects (CCE) estimator that Pesaran (2006) introduced. The method enables the analysis of both cross-sectional dependence and diverse country-specific

[1] HDI is a composite index developed by the UNDP to measure average achievement in three fundamental dimensions of human development: (1) a long and healthy life, measured by life expectancy at birth; (2) knowledge, assessed via mean years of schooling for adults and expected years of schooling for children; (3) decent standard of living, captured by gross national income (GNI) per capita (PPP), using a logarithmic transformation to reflect diminishing income returns. Each dimension is normalized to a 0-1 scale using fixed goalposts, and the HDI is computed as the geometric mean of these three-dimension indices (UNDP, 2025).

slope coefficients, which leads to enhanced result robustness and easier interpretation. Our research employed two methods: CCE Mean Group (CCEMG), which focuses on individual country coefficients and CCE Pooled (CCEP), which determines a shared effect for all countries.

A panel error correction model (ECM) helped us determine the speed at which countries return to equilibrium following temporary disturbances. The model includes lagged levels and first differences of variables to determine long-run relationships. To confirm the validity of the panel framework assumptions for different development contexts, we used Pesaran's (2021; 2007) CD tests for cross-correlation and CIPS tests for unit roots.

This study sought to answer the following research questions:

RQ1: What are the long-term effects of economic, social, and political globalisation on the Human Development Index (HDI)?

RQ2: How do these relationships differ across countries grouped by human development level, as estimated within a panel cointegration framework?

We begin with the background, motivation, research questions, and the analytical framework used to explore the relationship between globalisation and human development. The next section provides theoretical foundations and discusses key definitions of globalisation, followed by an analysis of factors moderating its impact on quality of life. Then, using data, econometric techniques (panel cointegration and error correction models), and variable construction, we present empirical findings by country development groups, verifying or refuting the hypotheses through statistical analysis. The final part of the research synthesises the results, highlights key policy implications, and emphasises the need for context-sensitive approaches to globalisation to enhance human development outcomes.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

There are many definitions of globalisation. In sociology and political science, Giddens (1990) describes globalisation as the 'intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa.' He emphasises the intensification of social relations, showing how distant occurrences and focusing on modernity as the foundation of these shifting relationships influence local events.

In fields such as sociology, cultural studies, and international relations, scholars often cite Robertson's (1992, p. 8) formulation. He highlights both the spatial ('compression') and the cultural or psychological ('consciousness') dimensions of globalisation, defining it as the 'compression of the world and the intensification of consciousness of the world as a whole.' Thus, Robertson emphasises how people's awareness of the world as a single place increases.

In political science, international relations, and globalisation studies, many scholars reference the definition by Held *et al.* (1999, p. 16), who describe globalisation as 'a process (or set of processes) that transforms the spatial organisation of social relations and transactions,' generating transcontinental or interregional flows and networks of activity, interaction, and power. They see globalisation as a set of processes that reorganise social relations and transactions over global distances, emphasising networks of activity, interaction, and power, and taking a largely structural and institutional approach.

Scholte centres his analysis on deterritorialisation, proposing that globalisation occurs when social interactions become less tied to specific places (2000). He emphasises that conventional territorial boundaries lose their significance in the formation of social relations, which is a concept further developed in the field of international political economy. According to Steger (2013), globalisation is the expansion and intensification of social relations and consciousness across world-time and world-space. His perspective, similar to Robertson's, combines both structural and subjective dimensions, focusing on how globalisation involves not only economic or political factors but also cultural and psychological ones.

Despite varying emphases, all five definitions share the view of globalisation as involving heightened interactions and interdependencies across long distances. Whether expressed as intensification, expansion, or compression, each author notes how faraway events can influence local or regional processes. Each also underlines that globalisation transcends national boundaries, creating flows of ideas, people,

and goods among previously distant societies. Giddens (1990), Held *et al.* (1999), and Steger (2013) explicitly mention the multiple dimensions of globalisation – economic, political, cultural, and sometimes ideological – while Robertson (1992) and Scholte (2000) imply similarly multifaceted changes to social life. All perspectives highlight some reconfiguration of space, time, or both: Giddens refers to 'linking distant localities,' Robertson to 'world compression,' Held *et al.* (1999), to 'transcontinental flows,' Scholte to 'delinking from territorial geography,' and Steger to 'expansion across world-time and world-space.'

These five definitions present diverse understandings of globalisation as a process that strengthens international connections across distant regions. Each presents a distinct perspective: Giddens focuses on reflexivity and modernity; Robertson emphasises cultural and psychological 'compression;' Held *et al.* (1999) highlight multidimensional processes and power dynamics; Scholte centres on deterritorialization; and Steger offers a balanced view of structural expansion and subjective intensification of consciousness. The five definitions demonstrate that globalisation functions as a complex, multi-layered process which transforms global social organisation and human interaction patterns.

These definitions demonstrate how globalisation shapes various aspects of life. However, we adopted a definition of globalisation consistent with the approach of Dreher A. (2006, p. 3-4), Clark (2000, p. 86) and Norris (2000, p. 155), which defines it 'as the process of creating networks of connections among actors at intra- or multi-continental distances, mediated through flows of people, information, ideas, capital, and goods. Globalisation is a process that erodes national boundaries, integrates national economies, cultures, technologies and governance, and produces complex relations of mutual interdependence.' While earlier definitions also emphasise transnational flows of people, ideas, and capital, this perspective more explicitly frames them as 'networks of connections' spanning different geographic scales. The analysis demonstrates how national borders have become increasingly permeable and different domains have merged, thereby supporting a broader understanding of globalisation as both an economic and socio-cultural process. It also emphasises the interconnectedness of nations and regions – a central theme in globalisation research. The KOF globalisation index[2] methodology adopts this perspective, which matches the research methodology of this study.

Consequently, the network-based perspective advanced by Dreher (2006), Clark (2000), and Norris (2000) allows for the translation of the chosen definition into the KOF methodology.

Factors Moderating the Impact of Globalisation on Quality of Life

From the standpoint of globalisation's impact on quality of life, it is useful to identify factors that moderate this complex relationship. Based on the literature review, there are four main moderating factors, namely: (i) state institutions and policies, (ii) level of development, (iii) cultural context, and (iv) economic diversification.

Firstly, let us focus on the state institutions and policies. Studies indicate that institutions which are well-organised (rule of law, effective tax systems, labour-market regulations) reduce the adverse effects of globalisation while increasing its beneficial aspects. Social policy measures, including education, healthcare and housing programs, function to redistribute economic growth benefits. Bergh and Nilsson (2010) examined the link between globalisation and life expectancy in their study Good for Living? Through panel-data analysis, they examined how the KOF Globalisation Index affects life expectancy as an indicator of quality of life. The research shows that life expectancy rises with higher globalisation levels, but institutions and policies create a stronger positive effect.

Furthermore, Bergh *et al.* (2016) investigated whether globalisation affects the quality of domestic institutions and how stronger or weaker institutions affect socio-economic outcomes, including welfare and quality of life. They found that globalisation can improve domestic institutional quality over time, which in turn reinforces the benefits of globalisation through better governance and economic performance.

[2] The KOF globalisation index is a comprehensive, multidimensional measure developed by the Konjunkturforschungsstelle Swiss Economic Institute to quantify the extent of globalisation for nearly every country in the world. It evaluates globalisation across three main dimensions – economic, social, and political – and is calculated using a combination of de facto (actual flows or activities) and de jure (policy or enabling conditions) indicators (KOF Swiss Economic Institute, 2025).

Dreher *et al.* (2008) examine how globalisation influences state institutions and policies which determine spending priorities for social welfare, education, and infrastructure. The authors demonstrate that increased openness through global integration leads governments to modify their expenditure patterns by allocating funds to manage economic challenges and maintain domestic political support. Strong institutions prove more vital for development results than integration does, according to Rodrik *et al.* (2004). The authors demonstrate that institutional quality factors, such as rule of law and property rights, create better economic development than geographic or trade elements, thus controlling globalisation's long-term effects.

In *Has Globalization Gone Too Far?* Rodrik (1997) argues that globalisation produces economic growth, but the neglect of domestic institutions alongside labour-market policies and social safety nets leads to decreased social well-being. The main discovery reveals that globalisation produces social tensions when governments do not implement suitable policies to distribute its consequences. The benefits of globalisation depend heavily on effective policy decisions and institutional arrangements to overcome its negative aspects.

These studies demonstrate how globalisation affects life quality by affecting life expectancy, welfare spending, economic development and human development, yet state institutions and policies act as intervening factors.

Secondly, let us focus on the level of development. This study's focus depends heavily on the moderating factor of a country's level of development. The integration of markets and capital flows benefits highly developed nations, which possess well-developed service sectors and broad educational access and strong social security programs. Developing nations which have not advanced in their development stage tend to experience severe economic instabilities that make international market competition more difficult, which might result in reduced quality of life.

Tsai (2007) studied the link between economic globalisation and well-being indicators, which include HDI across different developmental stages of countries. The benefits of globalisation tend to increase well-being measures, but this relationship strongly depends on both institutional capacity and developmental stage. The research by Samimi and Jenatabadi (2014) demonstrates that globalisation creates greater positive effects on growth and well-being indicators when complementary policies such as education and governance are implemented. Developing nations fail to benefit brought about by globalisation unless they establish robust institutions which determine whether globalisation brings substantial welfare improvements.

Dollar (2004) investigated the impact of globalisation on poverty reduction together with income inequality across nations based on their initial income levels. The study reveals that global economic integration leads to faster income growth, but the magnitude of these benefits relies on initial development conditions, which affect quality of life improvement. The benefits of globalisation tend to increase more significantly in nations with higher wealth and stronger institutions, yet poor countries may experience reduced advantages and growing inequalities when they do not implement adequate policies.

In *The Social Impact of Globalization in the Developing Countries*, Lee and Vivarelli (2006) state that globalisation produces diverse social effects which strongly depend on development stages and labour-market regulations. Welfare increases more substantially when globalisation occurs with proper labour protections and social policies in place. Chang *et al.* (2009) establish that openness leads to growth when countries maintain strong institutional foundations, yet institutional weaknesses can limit or undo the obtained benefits.

These studies demonstrate that globalisation leads to improved quality of life through growth and human development and poverty reduction, but the extent of these benefits depends on a nation's development level and institutional strength and policy environment.

The third moderating factor is cultural context. The distinct cultural characteristics, along with social trust and social capital, influence how societies respond to globalisation's economic and social transformations. Communities with strong social trust and inclusive social structures leverage changes to improve the quality of life.

Inglehart and Baker (2000) present their research on cultural values in different societies through their article 'Modernization, Cultural Change, and the Persistence of Traditional Values' to

demonstrate how economic development related to globalisation causes societies to adopt secular-rational and self-expression values. People maintain their traditional values strongly because these values shape their experience of modernisation. In Globalisation and Culture, Tomlinson (1999) demonstrates that cultural background functions as a key element for comprehending how different communities experience global economic and social transformations. The author shows that globalisation generates multifaceted changes to cultural identities, which produce new hybrid cultural patterns instead of a unified global culture.

Inglehart (2000) observes that societies becoming more globalised tend to adopt postmaterialist values which focus on self-expression and quality of life instead of economic survival. Different historical and cultural backgrounds influence how societies react to economic integration, thus affecting their social well-being and life satisfaction outcomes. Tov and Diener (2007) demonstrate that local cultural norms have a powerful effect on subjective well-being and show how globalisation's cross-cultural interactions interact with individualistic or collective orientations to produce different results.

The degree of standardised well-being improvements from global economic or technological transformations depends on cultural values and identities. Globalisation's economic benefits lose their effectiveness when cultural identities are perceived to be under the threat of social and psychological problems.

The last moderating factor is economic diversification. Economies that are less susceptible to external disturbances manage market fluctuations better, which arise from integration. Countries with a varied export base and manufacturing structure tend to perform better in times of worldwide crises.

The article by Elmawazini, Sharif, and Manga (2013) demonstrates in Globalisation, Economic Diversification, and Development in MENA Countries that economic diversification creates stability through reduced volatility of globalisation which produces stable economic and social results. Agosin (2009) discovered that countries which diversify their exports achieve stronger resilience through various export sectors, which generate better socio-economic results.

Lederman and Maloney (2012) investigate the impact of export composition on sustainable development and well-being. The authors contend that depending on limited export products makes economies more susceptible to international market disturbances, which negatively affects their growth potential. Papageorgiou and Spatafora (2012) used the example of low-income countries to show that economic diversification reduces output volatility and supports better quality-of-life indicator stability.

The research demonstrates that diverse economies function as buffers against global shocks, which enables globalisation to produce stable improvements in growth and trade and innovation for citizens. The dependence on one main commodity or sector creates unstable income levels, which threaten the progress of quality-of-life improvements. Policy makers can maximise social welfare benefits from globalisation through their support of export diversification and the development of various industrial sectors.

Findings and the Hypothesis

The consequences of globalisation exist between positive and negative extremes. The effects of globalisation on quality of life depend on specific economic, social, and political circumstances that vary between individual nations and regions. Public institutions function as key elements to reduce negative globalisation effects, such as inequality and financial crises and to distribute globalisation benefits through social policies. Provided adequate development levels, supportive cultural contexts, and economic diversification, strong institutions function as moderating factors, which enable countries to maximise globalisation benefits while ensuring its gains benefit the population as a whole.

Considering the reviewed literature, we formulated the main research hypothesis:

H1: In its economic, social, and political dimensions, globalisation exerts a significant long-term impact on the Human Development Index (HDI), with the nature and magnitude of this effect varying across countries at different levels of development.

Given that the study separately investigates the three dimensions of globalisation (a) economic, (b) social, and (c) political), we formulated the following sub-hypotheses:

Ha: Economic globalisation has a positive long-run effect on HDI, but this effect is conditional on the quality of domestic institutions and a country's level of development.

Hb: Social globalisation is positively and significantly associated with HDI across all development groups, especially in low and medium HDI countries.

Hc: Political globalisation positively affects HDI primarily in high and very high human development countries, where institutional frameworks are capable of translating international cooperation into domestic development gains.

Empirical studies such as Rodrik (2004), Bergh and Nilsson (2010), Dreher *et al.* (2008), and Tsai (2007) support **Ha**. These scholars argue that the benefits of economic openness depend largely on institutional quality, governance effectiveness, and the policy environment. **Hb** is grounded in the work of Inglehart and Baker (2000), Tov and Diener (2007), and Tomlinson (1999), who emphasise that social globalisation enhances human well-being by facilitating knowledge diffusion, educational exchange, cultural connectivity, and access to health-related information. **Hc** draws on the research of Held and McGrew (1999), Dreher (2006), and Norris (2000), who contend that more advanced economies are better positioned to capitalise on political globalisation due to their stronger institutional capacity and higher degree of global policy engagement.

RESEARCH METHODOLOGY

The research method employed will be panel data analysis. It is a statistical technique that entails the analysis of data collected from several units (*e.g.*, countries) at different time points (*e.g.*, years). Panel data analysis combines both cross-sectional analysis (country-to-country) and time-series analysis (year-to-year).

Each country has its own fixed characteristics (geography, culture, or institutional framework) that do not change over time to control for unobserved heterogeneity. Panel analysis can isolate these constant factors, reducing omitted-variable bias. The method also allows for tracking changes over time. Because data are collected over multiple years, researchers can capture dynamic effects, such as the impact of policy reforms or economic shocks, on the variables of interest. The third reason for choosing this tool was to improve efficiency and robustness. The larger the number of observations (countries x years), the higher the reliability of statistical estimates and the possibility of detecting dependencies. Panel data methods utilise both cross-sectional and temporal dimensions to provide a more nuanced and accurate picture than single-year or single-country analyses alone.

For the purposes of this study, we measured the process of globalisation by the KOF globalisation index. Table 1 presents its structure. It is a composite index measuring globalisation for every country in the world along the economic, social, and political dimensions:

- economic globalisation characterises long-distance flows of goods, capital, and services as well as information and perceptions that accompany market exchanges,
- social globalisation expresses the spread of ideas, information, images and people,
- political globalisation characterises the diffusion of government policies.

On the other hand, the outcome variable of the study would be the most widely used measure of the quality of life, *i.e.*, the human development index (HDI). The HDI captures the average level of achievement across three key aspects of human development: living a long and healthy life, acquiring knowledge, and enjoying a decent standard of living (UNDP, 2025). One calculates it as the geometric mean of normalised indicators corresponding to each of these three dimensions.

The HDI measures health through life expectancy at birth. It assesses education using the mean years of schooling for adults aged 25 and older and the expected years of schooling for children at the start of their education. Next, it measures the standard of living by gross national income per capita. To reflect the diminishing return of income at higher levels, the HDI uses the logarithm of gross national income. Finally, it combines the three-dimensional indices into a composite index through their geometric mean.

For the study, we selected countries from different areas and with different levels of development. Such a selection allowed us to capture their contrast and diversity.

We selected countries based on their classification by the human development index (HDI), ensuring balanced representation across four development groups: very high, high, medium, and low.

Table 1. Structure of the KOF globalisation index

GLOBALISATION INDEX, DE FACTO	WEIGHTS	GLOBALISATION INDEX, DE JURE	WEIGHTS
Economic globalisation, de facto	**33.3**	**Economic globalisation, de jure**	**33.3**
Trade globalisation, de facto	50.0	Trade globalisation, de jure	50.0
Trade in goods	38.8	Trade regulations	26.8
Trade in services	44.7	Trade taxes	24.4
Trade partner diversity	16.5	Tariffs	25.6
		Trade agreements	23.2
Financial globalisation, de facto	50.0	Financial globalisation, de jure	50.0
Foreign direct investment	26.7	Investment restrictions	33.3
Portfolio investment	16.5	Capital account openness	38.5
International debt	27.6	International investment agreements	28.2
International reserves	2.1		
International income payments	27.1		
Social globalisation, de facto	**33.3**	**Social globalisation, de jure**	**33.3**
Interpersonal globalisation, de facto	33.3	Interpersonal globalisation, de jure	33.3
International voice traffic	20.8	Telephone subscriptions	39.9
Transfers	21.9	Freedom to visit	32.7
International tourism	21.0	International airports	27.4
International students	19.1		
Migration	17.2		
Informational globalisation, de facto	33.3	Informational globalisation, de jure	33.3
Used internet bandwidth	37.2	Television access	36.8
International patents	28.3	Internet access	42.6
High technology exports	34.5	Press freedom	20.6
Cultural globalisation, de facto	33.3	Cultural globalisation, de jure	33.3
Trade in cultural goods	28.1	Gender parity	24.7
Trade in personal services	24.6	Human capital	41.4
International trademarks	9.7	Civil liberties	33.9
McDonald's restaurant	21.6		
IKEA stores	16.0		
Political globalisation, de facto	**33.3**	**Political globalisation, de jure**	**33.3**
Embassies	36.5	International organisations	36.2
UN peacekeeping missions	25.7	International treaties	33.4
International NGOs	37.8	Treaty partner diversity	30.4

Source: Gygli *et al.*, 2019.

Table 2. Division of countries according to the HDI index in 2022

Very High Human Development Countries (VHHDCs) HDI≥0.800	High Human Development Countries (HHDCs) 0.700<HDI<0.799	Medium Human Development Countries (MHDCs) 0.550<HDI<0.699	Low Human Development Countries (LHDCs) HDI<0.550
Australia (Oceania) – **HDI=0,946** – open economy, large inflow of migration, large exchange of raw materials; **Belgium** (Europe) – **HDI=0,942** – highly globalised economy, strong international trade links, EU institutional hub;	**Albania** (Europe) – **HDI=0,789** – small transition economy, progressing in market reforms and regional integration, candidate for EU membership; **Brazil** (South America) – **HDI=0,760** – a large domestic market, exporter of raw materials, part of the BRICS group; **Bulgaria** (Europe) – **HDI=0,799** – EU member	**Bangladesh** (South Asia) – **HDI=0,670** – dynamically developing clothing sector, high importance of production for export; **Bolivia** (South America) – **HDI=0,698** – resource-rich economy with significant natural gas and mineral exports, high dependence on commodity prices; **Cambodia** (Southeast Asia) – **HDI=0,600** – fast-growing	**Afghanistan** (South Asia) – **HDI=0,462** – conflict-affected country with low levels of development, heavily dependent on foreign aid and agriculture; **Burundi** (East Africa) – **HDI=0,420** – one of the world's poorest countries, reliant on subsistence farming, with limited integration into the global economy;

Very High Human Development Countries (VHHDCs) HDI≥0.800	High Human Development Countries (HHDCs) 0.700<HDI<0.799	Medium Human Development Countries (MHDCs) 0.550<HDI<0.699	Low Human Development Countries (LHDCs) HDI<0.550
Germany (Europe) – **HDI=0,950** – the largest economy in the EU, very high integration with the world market; **Iceland** (Europe) – **HDI=0,959** – small, open economy, high standard of living, reliant on tourism and renewable energy exports; **Japan** (East Asia) – **HDI=0,920** – highly developed, with a global network of production and trade; **Netherlands** (Europe) – **HDI=0,946** – major global trading hub, open and export-oriented economy, advanced infrastructure; **Norway** (Europe) – **HDI=0,966** – a highly developed country, based on the export of raw materials (oil), and high quality of life indicators; **Singapore** (Southeast Asia) – **HDI=0,949** – small but strongly globalised leader in the region (financial and trade centre). **Switzerland** (Europe) – **HDI=0,967** – advanced economy, strong financial sector, global leader in innovation and stability; **United States** (North America) – **HDI=0,927** – one of the largest economies, leader in the flow of capital and technology, high level of development.	with an open, export-oriented economy, undergoing structural modernisation since the post-socialist transition; **China** (East Asia) – **HDI=0,788** – a key example of dynamic development and intensive global integration in recent decades; **Dominican Republic** (Caribbean) – **HDI=0,766** – one of the fastest-growing economies in Latin America, reliant on tourism, remittances, and free-trade zones; **Indonesia** (Southeast Asia) – **HDI=0,713** – emerging economy with a large population, strong commodity exports, and increasing global economic engagement; **Mexico** (North America) – **HDI=0,781** – major manufacturing hub integrated with the U.S. market, key participant in regional trade agreements (e.g., USMCA); **Peru** (South America) – **HDI=0,762** – resource-rich economy, heavily dependent on mining exports, increasingly integrated into global trade networks; **South Africa** (RSA) (Africa) – **HDI=0,717** – the most industrialised country on the continent, strongly connected to the global raw materials market; **Vietnam** (Southeast Asia) – **HDI=0,726** – rapidly growing economy, important producer of electronics and textiles, increasingly integrated with world markets.	low-income economy, reliant on garment exports, tourism, and foreign investment **India** (South Asia) – **HDI=0,644** – a large and rapidly developing market, growing role in global services (IT); **Morocco** (North Africa) – – **HDI=0,698** diversified economy with strong trade ties to Europe, key sectors include agriculture, mining, and manufacturing; **Nicaragua** (Central America) – **HDI=0,669** – low-income, export-oriented economy, dependent on agriculture, remittances, and foreign aid; **Nepal** (South Asia) – **HDI=0,601** – economy largely dependent on agriculture and remittances; **Venezuela** (South America) – **HDI=0,699** – oil-dependent economy facing prolonged economic and political crisis, high inflation and emigration; **Zambia** (Africa) – **HDI=0,569** – mineral-exporting country, especially copper, vulnerable to global commodity price fluctuations; **Zimbabwe** (Africa) – **HDI=0,550** – post-crisis economy undergoing stabilization, reliant on agriculture and mining, limited global economic integration.	**Central African Republic** (Central Africa) – **HDI=0,387** – fragile state with ongoing conflict, rich in natural resources but with weak institutions and minimal development; **Congo** (Democratic Republic of the Congo) (Central Africa) – **HDI=0,481** – vast mineral wealth (e.g., cobalt, copper), but limited infrastructure and persistent political instability; **Guinea** (West Africa) – **HDI=0,471** – resource-rich (notably bauxite), but marked by poverty, political instability, and underdeveloped infrastructure; **Mali** (West Africa) – **HDI=0,410** – landlocked, low-income economy reliant on agriculture and gold mining, facing internal conflict and climate challenges; **Mozambique** (Southeast Africa) – **HDI=0,461** – a country rich in raw materials (natural gas), but low level of development and poor infrastructure; **Niger** (West Africa) – **HDI=0,394** – one of the least developed countries, with an economy based on subsistence agriculture and uranium mining; **Sierra Leone** (West Africa) – **HDI=0,458** – post-conflict country, dependent on mineral exports (diamonds), with ongoing challenges in infrastructure and poverty reduction; **Yemen** (Middle East) – **HDI=0,424** – conflict-ridden country with a collapsing economy, severe humanitarian crisis, and limited global integration.

Source: own study.

We chose ten countries from each group, reflecting both geographical diversity and data availability for the period 1990-2022. This balanced panel design allowed for robust comparison of globalisation's long-term effects on human development across different development contexts, while ensuring consistent data quality for econometric analysis.

We measured all the modelled variables in points, and their values vary between 0 and 100. We estimated the long-run relationship given by the log-linear form:

$$h_{it} = \beta_{1i} e_{it} + \beta_{2i} s_{it} + \beta_{3i} p_{it} + u_{it} \quad (1)$$

in which h_{it} is the logarithm of the HDI of the ith country in year t, e_{it} is the logarithm of the economic globalisation index, s_{it} is the logarithm of the social globalisation index, and p_{it} is the logarithm of the political globalisation index, $i = 1,2, \dots, N$, $t = 1,2, \dots, T$. In all considered groups, we examined the determination of the HDI in 10 countries ($N = 10$) over 33 years ($T = 33$). Following Pesaran (2006) (see also Kapetanios *et al.* (2011), Holly *et al.* (2010)), we assumed that u_{it} had a multi-factor structure ($u_{it} = \gamma_i' f_t + \varepsilon_{it}$, where f_t was a vector of unobserved common shocks/factors and ε_{it} were the individual-specific errors). Through the unobserved common components of u_{it} , we accounted for different factors that may drive the HDI. Note that according to equation (1), we allowed the coefficients of the long-run relationship to vary individually across countries. We wanted to estimate the mean effect, $\beta = E(\beta_i)$, so we considered a random coefficient model, *i.e.*, $\beta_i = \beta + \nu_i, \nu_i \sim iid(0, \Omega_i)$. To estimate this mean impact of the selected variables on the HDI, we used the common correlate effects (CCE) estimator proposed by Pesaran (2006), which is consistent under heterogeneity and cross-sectional dependence. We considered both the CCE mean group estimator (CCEMG), which is the average of the individual CCE estimators, and the CCE pooled estimator (CCEP), which one obtains by pooling the information over the cross sections (see *e.g.*, Pesaran, 2006 and Holly *et al.,* 2006). We used the same methods to estimate the panel error correction model:

$$\Delta h_{it} = \phi_i + \alpha_i \left(h_{i,t-1} - \hat{\beta}_{1i} e_{i,t-1} - \hat{\beta}_{2i} s_{i,t-1} - \hat{\beta}_{3i} p_{i,t-1}\right) + \delta_{1i} \Delta e_{it} + \\ + \delta_{2i} \Delta s_{it} + \delta_{3i} \Delta p_{it} + \zeta_{it} \quad (2)$$

The coefficients α_i measure the speed with which the HDI adjusts to a shock. We can also approximate the half-life of such a shock as $-\ln(2) / \ln(1 + \alpha_i)$. The point estimates of the mean long-run elasticities are denoted by $\hat{\beta}_{ji}, j = 1,2,3$.

RESULTS AND DISCUSSION

First, we tested for cross-sectional dependence in the panels. We used a cross dependence (CD) test proposed by Pesaran (2021), which one can apply to both stationary and unit root dynamic heterogeneous panels, allowing for structural breaks. The results (Table 3) show statistically significant cross-correlation in both levels and first differences of the variables across almost all panels; except for the first differences of p_{it} in the panel of highly developed countries (the political globalisation index in the HHDCs). Given these results, we chose Pesaran's CIPS tests (Pesaran, 2007) to test for unit root behaviour. To capture the trend behaviour of the levels, we run the CIPS test with a constant and a linear trend ($CIPS_{\mu t}$), while in the first differences regressions, we only include a constant ($CIPS_{\mu}$). In all panels, we could not reject the unit root hypothesis for h_{it} at all commonly considered significance levels (0.01, 0.05, 0.1). In the case of very high and low human development countries, we also did not reject the hypothesis of a unit root trend in s_{it}. In the group of highly developed countries we did not reject the unit root hypothesis for e_{it}, and at the 0.01 and 0.05 significance levels, we could not reject the unit root hypothesis for e_{it} in the panel of medium-developed countries. The CIPS tests confirmed that the processes were at most integrated of order one (I(1)), as unit roots were present in levels but not in first differences. This justified proceeding with cointegration analysis. Thus, at most, the variables exhibit $I(1)$ behaviour. In each panel, two variables can be considered $I(1)$, making it reasonable to explore the possibility of cointegration between them. We could also augment this relationship with $I(0)$ processes, so we could proceed with estimating the relationship defined by equation (1).

Table 3. Values of statistics of diagnostic tests

Variable	h	e	s	p		Δh	Δe	Δs	Δp
VHHDCs									
CD	37.757***	34.537***	36.500***	30.061***	CD	9.543***	15.715***	9.003***	17.114***
$CIPS_{\mu t}$	-2.373	-3.063**	-2.689	-4.787***	$CIPS_{\mu}$	-5.169***	-5.633***	-5.294***	-5.712***
HHDCs									
CD	33.909***	7.256***	37.439***	30.095***	CD	7.354***	2.772***	8.968***	1.612
$CIPS_{\mu t}$	-1.825	-2.487	-3.611***	-2.940**	$CIPS_{\mu}$	-4.345***	-5.565***	-5.985***	-5.474***
MHDCs									
CD	36.215***	27.719***	37.393***	32.495***	CD	11.209***	5.548***	5.801***	7.315***
$CIPS_{\mu t}$	-2.081	-2.860*	-3.199***	-3.660***	$CIPS_{\mu}$	-4.173***	-5.198***	-5.387***	-5.211***
LHDCs									
CD	33.029***	12.394***	37.151***	26.674***	CD	7.024***	2.400**	7.204***	10.520***
$CIPS_{\mu t}$	-1.923	-3.021**	-2.673	-3.654***	$CIPS_{\mu}$	-4.271***	-5.363***	-5.774***	-5.874***

Notes: 0.1, 0.05 and 0.01 significance denoted by *, ** and ***, respectively; CD – Pesaran's CD test for cross-sectional dependence in panels; $CIPS_{\mu}$ – Pesaran's CIPS unit root test with a constant (critical values: $z_{0.01} = -2.57$, $z_{0.05} = -2.33, z_{0.1} = -2.21$, Pesaran, 2007); $CIPS_{\mu t}$ – Pesaran's CIPS unit root test with a constant and a linear trend (critical values: $z_{0.01} = -3.10, z_{0.05} = -2.86, z_{0.1} = -2.73, \text{Pesaran}, 2007$).
Source: own study in R, CD test – package plm, CIPS test – own procedure.

Findings for the Group of Very High Human Development Countries (VHHDCs)

The long-run economic globalisation index elasticities ranged from -0.398 in the Netherlands to 0.079 in Germany and were positive in four countries (Australia, Belgium, Germany and Singapore), with an average effect not statistically significant. The long-run elasticities for social globalisation ranged from 0.090 in the Netherlands to 0.241 in the United States, with negative values recorded in three countries (Germany, the Netherlands, and Norway). Social globalisation was significant and positive on average (CCEMG: 0.069, CCEP: 0.080). The third dimension was political and had no significant average effect. In five countries (Australia, Iceland, Japan, Norway, and Switzerland) the long-run political globalisation index elasticities were negative. In the considered group, they ranged from -0.167 in Switzerland to 0.061 in Belgium.

Table 4. Very high human development countries: Chosen point estimates

Variables	CCEMG	asymptotic error of CCEMG	CCEP	asymptotic error of CCEP
KOF economic elasticity	-0.032	0.045	0.004	0.021
KOF social elasticity	0.069**	0.033	0.080**	0.038
KOF political elasticity	-0.005	0.022	-0.013	0.011
Speed of adjustment	-0.841***	0.074	–	–

Note: 0.1, 0.05 and 0.01 significance denoted by *, ** and ***, respectively.
Source: own calculations in R, package plm and own procedures.

In all countries, the HDI adjusted significantly to the estimated long-run relationship at the 0.01 significance level, confirming cointegration between the series analysed for all countries. Estimates of the half-life of a shock to the HDI ranged from 2.3 months in Belgium to 1.3 years in Switzerland, while overshooting is observed in Australia, suggesting that the adjustment was cyclical.

Findings for the Group of High Human Development Countries (HHDCs)

The long-run economic globalisation index elasticities ranged from -0.072 in Afghanistan to 0.294 in Yemen, with positive values recorded in five countries: Burundi, Mali, Niger, Sierra Leone, and Yemen. This means that economic globalisation effects were heterogeneous, with positive coefficients in half of the countries. For the social globalisation index, elasticities span from -0.334 in Yemen to 0.565 in the Central African Republic. We observed positive values in four countries, *i.e.*, Afghanistan, the Central African Republic, Guinea, and Mali, but social globalisation was not signif-

icant on average. Except for Afghanistan, all countries exhibited positive long-run political globalisation index elasticities, which ranged from -0.091 in Afghanistan to 0.261 in Mali.

Table 5. High human development countries: Chosen point estimates

Variables	CCEMG	asymptotic error of CCEMG	CCEP	asymptotic error of CCEP
KOF economic elasticity	0.019	0.033	0.056	0.056
KOF social elasticity	-0.022	0.079	-0.023	0.085
KOF political elasticity	0.118***	0.030	0.149***	0.029
Speed of adjustment	-0.757***	0.055	–	–

Note: 0.1, 0.05 and 0.01 significance denoted by *, ** and ***, respectively.
Source: own study in R, package plm and own procedures.

Political globalisation was significant and positive (CCEMG: 0.118, CCEP: 0.149), supporting Hc. In every country analysed, the HDI showed a statistically significant adjustment to the estimated long-run relationship at the 0.01 level, confirming the presence of cointegration among the examined series. The estimated half-life of a shock to h_{it} ranges from 3.6 months in Mozambique to 10 months in Yemen. However, in Burundi and the Central African Republic, the adjustment process was characterised by overshooting, indicating a cyclical pattern of correction.

Findings for the Group of Medium Human Development Countries (MHDCs)

The long-run elasticities for the economic globalisation index varied from -0.042 in Peru to 0.034 in Vietnam, with positive values observed in only two countries: South Africa and Vietnam, but were not significant on average. For the social globalisation index, long-run elasticities spanned from -0.05 in Indonesia to 0.179 in South Africa. Social globalisation was positive and significant (CCEMG: 0.044), supporting Hb. We recorded negative values in four countries, *i.e.*, Albania, Bulgaria, Indonesia, and Vietnam. Regarding the political globalisation index, four countries – China, the Dominican Republic, Indonesia, and Peru – exhibit positive long-run elasticities, which ranged overall from -0.129 in South Africa to a high of 0.201 in Indonesia. Therefore, political globalisation was not significant on average and even negative in several cases.

Table 6. Medium human development countries: Chosen point estimates

Variables	CCEMG	asymptotic error of CCEMG	CCEP	asymptotic error of CCEP
KOF economic elasticity	-0.011	0.007	-0.028*	0.015
KOF social elasticity	0.044*	0.026	0.005	0.030
KOF political elasticity	-0.007	0.027	-0.029	0.022
Speed of adjustment	-0.696***	0.061	–	–

Note: 0.1, 0.05 and 0.01 significance denoted by *, ** and ***, respectively.
Source: own study in R, package plm and own procedures.

At the 0.01 significance level, the HDI exhibited a statistically significant adjustment to the estimated long-run relationship across all countries, confirming cointegration among the analysed series. The estimated half-life of a shock to h_{it} ranged from 2.6 months in Vietnam to 1.25 years in Bulgaria.

Findings for the Group of Low Human Development Countries (LHDCs)

Economic globalisation effects were again heterogeneous, with no significant average effect. The long-run economic globalisation index elasticities ranged from -0.111 in Morocco to 0.095 in Zimbabwe, with positive values observed in four countries: Bolivia, Nepal, Nicaragua, and Zimbabwe. For the social globalisation index, elasticities extended from -0.193 in Morocco to a high of 0.491 in Cambodia, with negative values found in only two countries, *i.e.*, Bangladesh and Morocco. Thus, social globalisation was strongly positive and significant (CCEMG: 0.117), especially in countries with limited public services. The long-run political globalisation index elasticities were negative in four countries, *i.e.*, Bangladesh, Bolivia, India, and Nepal, and spanned from -0.061 in Nepal to 0.227 in Zambia. It showed no significant average effect; coefficients varied widely.

Table 7. Low human development countries: Chosen point estimates

Variables	CCEMG	asymptotic error of CCEMG	CCEP	asymptotic error of CCEP
KOF economic elasticity	-0.011	0.021	0.004	0.025
KOF social elasticity	0.117*	0.062	0.157*	0.081
KOF political elasticity	0.035	0.029	0.016	0.035
Speed of adjustment	-0.703***	0.066	–	–

Note: 0.1, 0.05 and 0.01 significance are denoted by *, ** and ***, respectively.
Source: own study in R, package plm and own procedures.

At the 0.01 significance level, the HDI significantly adjusted to the estimated long-run relationship in all countries, confirming cointegration among the analysed series. The estimated half-life of a shock to h_{it} ranged from just under four months in Bangladesh to 1.4 years in Nicaragua. However, in Nepal, the adjustment followed a cyclical pattern.

In all of the panels analysed, the point estimates of the individual slope coefficients varied enormously across the cross-sectional units, so that the mean group estimates of the average effects were more reliable. For this reason, we focused on the average effects obtained using the CCEMG estimator. The average speed of adjustment coefficient was significant in all considered groups, and the average half-life varied from about 4.5 months for very high developed countries to about 7 months in the case of medium and low developed countries. The average long-run elasticity of the global economic index was not significant in any of the groups of countries considered. The average elasticity of the social global index was positive and significant in the groups of very high, medium, and low developed countries and was 0.064, 0.044, and 0.117, respectively. For highly developed countries, the average long-run elasticity of the political global index was significant, and the point estimate was 0.118. We observed that, on average, a 1% change in the political index led to a 0.11% change in the HDI.

We positively verified the main hypothesis (H) that globalisation, in its economic, social, and political dimensions, exerts a significant long-term impact on the Human Development Index (HDI), with the nature and magnitude of this effect varying across countries at different levels of development. The study confirmed that at least one dimension of globalisation significantly affects HDI in every development group, and that the impact varies across country groups (*e.g.*, political globalisation only significant in HHDCs; social globalisation significant in VHHDCs, MHDCs, LHDCs).

We neither verified nor partially refuted the sub-hypothesis (**Ha**) that economic globalisation has a positive long-run effect on HDI, but this effect is conditional on the quality of domestic institutions and a country's level of development. The average long-run elasticity of economic globalisation was not statistically significant in any of the four country groups (CCEMG results). While individual countries showed variation (positive and negative), the mean effect was null. We discussed the conditional effect on institutions in theory, but did not empirically test it in this study.

We positively verified sub-hypothesis (**Hb**) that social globalisation is positively and significantly associated with HDI across all development groups, especially in low and medium HDI countries. Although we observed individual negative effects in some very highly developed countries, the group-level effect remained significant and positive. We found a statistically significant positive effect of social globalisation on HDI in VHHDCs, MHDCs, and LHDCs (with average elasticities of 0.064, 0.044, and 0.117, respectively). In HHDCs, the relationship was not statistically significant, which is consistent with the hypothesis that the positive effect was stronger in lower and medium development groups.

We partially verified (or verified for HHDCs) sub-hypothesis (**Hc**) that political globalisation positively affects HDI primarily in high and very high human development countries, where institutional frameworks are capable of translating international cooperation into domestic development gains. Political globalisation has a positive and statistically significant effect only in HHDCs (elasticity = 0.118). In VHHDCs, MHDCs, and LHDCs the effect was not significant, and in some cases, even negative for individual countries. This matches the hypothesis' claim that only high-HDI countries benefit meaningfully from political globalisation.

Our empirical results revealed several key findings. Social globalisation demonstrates a consistent and statistically significant positive relationship with HDI across countries that have very high, medium, and low human development levels. The increased availability of global information combined with cultural exchange and international human networks leads to better educational results and healthcare access and improved living standards especially in regions with minimal service availability. The effects of economic globalisation on HDI show no significant long-term relationship but produce different outcomes between individual nations. The advantages of economic integration appear to rely on domestic factors which include governance quality and infrastructure development and the ability to absorb foreign investment. Political globalisation shows a statistically significant positive relationship only with high human development countries because these nations possess better capabilities to convert international cooperation into domestic policy enhancements. The results demonstrate that human development index (HDI) shows significant adjustments to its long-run path across all studied country groups, which supports the cointegration hypothesis between globalisation and human development. Very high HDI countries demonstrate the average adjustment speed because they maintain robust institutional systems for responding to disturbances.

This article provides a general understanding of globalisation's influence on quality of life through its combination of panel econometric methods with separate evaluations of different country groups. The research demonstrates that globalisation produces different effects across nations while showing how tailored approaches can maximise human development benefits from global integration.

CONCLUSIONS

This study presents an empirical analysis of the long-run effects of economic, social, and political globalisation on human development, measured by the Human Development Index (HDI), using a balanced panel of countries classified across four levels of development. By applying robust panel cointegration techniques, the analysis reveals that globalisation does not act as a uniform force but rather comprises a set of interrelated processes whose developmental effects are strongly dependent on national context and institutional capacity. The findings contribute to the expanding body of literature that critically evaluates how global integration interacts with domestic structures to shape long-term human well-being.

Among the three dimensions examined, social globalisation emerges as the most consistently beneficial. The study found a statistically significant and positive relationship between social globalisation and HDI in countries with very high, medium, and low levels of development. These results support the argument that global cultural exchange, access to international information, digital connectivity, and educational flows enhance human development outcomes, particularly in countries where public service provision is constrained. These findings align with those of Sapkota (2011) and Ulucak *et al.* (2020), who highlight the positive role of social globalisation in extending life expectancy and improving access to health and education in developing economies. Similarly, Behera and Sahoo (2023) emphasise that international information sharing and communication technologies have a measurable and favourable effect on the quality of life in emerging economies.

By contrast, economic globalisation does not exhibit a significant average long-term impact on HDI across any of the development groups. Its effects are highly heterogeneous and context-dependent, with positive impacts observed only in select countries. This suggests that economic openness alone is not sufficient to drive improvements in human development unless it is supported by robust domestic institutions, inclusive policy frameworks, and effective governance structures. These results confirm the conditional relationship proposed by Figueroa (2014) and Cieślik (2014), who argue that without supportive institutions and social protections, the benefits of global trade and capital flows may bypass large segments of the population. Asongu (2012) also provides evidence that absorptive capacity, including technological readiness and financial inclusion, mediates the effects of globalisation on inclusive development.

Political globalisation shows a significant positive effect only in the group of high human development countries. This likely reflects the greater institutional maturity and administrative capacity in

these nations, which enables them to convert international political engagement and treaty participation into effective domestic development outcomes. In contrast, low- and middle-income countries, with weaker political institutions, appear unable to fully leverage their involvement in global governance for human development gains. These findings are consistent with the conclusions of Figueroa (2014) and Ulucak *et al.* (2020), who underscore that political globalisation tends to benefit countries with the institutional sophistication necessary to translate global norms into national action.

From a methodological perspective, the study confirms the existence of cointegration between globalisation dimensions and HDI across all four development groups, indicating stable long-run relationships. The speed of adjustment to long-run equilibrium following a shock is highest among very high HDI countries, reflecting their stronger institutional responsiveness and resilience. In several cases, particularly in countries with more advanced institutions, the adjustment process exhibits cyclical behaviour or overshooting, suggesting complex feedback mechanisms between globalisation and development processes.

These results offer several important policy implications. Firstly, the evidence that social globalisation has consistent positive effects highlights the need for policies that foster international educational exchange, digital inclusion, and global knowledge-sharing partnerships, especially in lower- and middle-income countries. Secondly, the absence of a significant average effect of economic globalisation suggests that policymakers should not rely solely on trade and financial openness to enhance human development. Instead, one should approach economic globalisation cautiously and aligned with national development strategies that prioritise equity and institutional capacity-building. Finally, the benefits of political globalisation appear contingent on a country's ability to participate meaningfully in international governance, implying that strengthening public institutions is a prerequisite for leveraging global political engagement.

This study also reinforces the conclusion that globalisation's developmental impact is highly conditional and must be tailored to local contexts. While globalisation can be a force for improving the quality of life, this is not guaranteed. Realising its potential requires active policy engagement, long-term investments in human capital, and the construction of resilient institutions that can absorb, adapt to, and channel global influences effectively.

Despite its contributions, this study is subject to several limitations. Firstly, the use of composite indices such as the KOF Globalisation Index and the Human Development Index, while common in the literature, may mask internal variation and are influenced by subjective weighting schemes. Secondly, the analysis focuses mainly on long-run relationships. Thirdly, grouping countries by HDI level, while analytically convenient, may obscure heterogeneity related to regional characteristics, governance quality, or cultural factors. Fourth, the models do not explicitly incorporate mediating variables such as institutional quality, income inequality, or social policy indicators, which could significantly influence the observed relationships. Lastly, the post-2020 global environment has undergone major transformations due to the COVID-19 pandemic and geopolitical disruptions, which the historical data may not fully reflect.

To build upon these findings, future research could pursue several promising directions. Firstly, scholars could examine the short-run dynamics of error correction models in more detail, or employ time-varying parameter techniques to capture how globalisation affects human development in the presence of structural breaks. Secondly, disaggregating the globalisation indices to study specific sub-components, such as internet access, student mobility, and trade in services, may uncover more nuanced effects. Thirdly, including institutional quality indicators directly into the econometric framework would allow researchers to test governance as a mediating factor. Finally, updated studies are needed to evaluate how post-pandemic shifts in global integration have reshaped the relationship between globalisation and development, particularly in the domains of health, education, and social resilience.

In conclusion, globalisation remains a powerful yet uneven determinant of human development. Ensuring that its benefits are widely shared and aligned with the broader goal of improving quality of life for all requires deliberate, context-sensitive policy choices. This study provides evidence-based insights to guide such efforts and underscores the importance of combining global engagement with local institutional strength to achieve inclusive development.

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Acknowledgements and Financial Disclosure

Justyna Wróblewska's contribution is cofinanced from the subsidy granted to Krakow University of Economics (project no. 036/EIE/2025/POT). In case of Dorota Kuder the article presents the results of the Project no. 029/EEZ/2025/POT financed from the subsidy granted to the Krakow University of Economics.

Use of Artificial Intelligence

The authors acknowledge the use of AI-based tools (e.g., ChatGPT) for language refinement only. All scientific content, analysis, and interpretation were developed independently by the authors.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Published by Krakow University of Economics – Krakow, Poland

The publisher:

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ISSN 2658-1841