relevant results and theoretical developments
of science and research

16
2026
issue 1

AD ALTA

Journal of Interdisciplinary Research

AD ALTA: Journal of Interdisciplinary Research
Double-Blind Peer-Reviewed
Volume 16, Issue 1, 2026
Number of issues per year: 2

MAGNANIMITAS Assn.

AD ALTA: JOURNAL OF INTERDISCIPLINARY RESEARCH

JOURNAL NO.: **16/01** (VOLUME 16, ISSUE 1), JULY, 2026

ADDRESS: CESKOSLOVENSKE ARMADY 300, 500 03, HRADEC KRALOVE, THE CZECH REPUBLIC, TEL.: 498 651 292, EMAIL: INFO@MAGNANIMITAS.CZ

ISSN 1804-7890, ISSN 2464-6733 (ONLINE)
AD ALTA IS A PEER-REVIEWED JOURNAL OF INTERNATIONAL SCOPE.
2 ISSUES PER VOLUME.

AD ALTA: JOURNAL OF INTERDISCIPLINARY RESEARCH USES THE RIV BRANCH GROUPS AND BRANCHES, BUT THE JOURNAL IS NOT A PART OF RIV. THE RIV IS ONE OF PARTS OF THE R&D INFORMATION SYSTEM. THE RIV HAS COLLECTED AN INFORMATION ABOUT RESULTS OF R&D LONG-TERM INTENTIONS AND R&D PROJECTS SUPPORTED BY DIFFERENT STATE AND OTHER PUBLIC BUDGETS, ACCORDING TO THE R&D ACT [CODE NUMBER 130/2002], THE CZECH REPUBLIC.

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UNDERSTANDING SCIENTIFIC TEXTS AS A PREREQUISITE FOR SUCCESS IN SCIENCE EDUCATION

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Funded by the Grant Agency of the Faculty of Education, Catholic University in Ružomberok, under Project No. 5/1a/2026.

Reading comprehension is a key competence influencing students' success in science education. This study analyzes primary school students' understanding of scientific texts through tasks of varying cognitive demand. It focuses on information retrieval, processing, and interpretation. Three main areas were identified: information retrieval, working with tables, and integration of multiple sources of information. Students achieved high success in tasks based on explicit information, whereas performance declined in tasks requiring interpretation and integration. Error analysis confirmed difficulties mainly in these higher-order cognitive processes. The findings highlight the need for systematic development of reading and scientific literacy through didactic strategies that promote deeper text comprehension. The results are consistent with both national and international research.

Keywords: cognitive demand; information interpretation; primary school students; reading comprehension; science education; scientific literacy; scientific texts.

1 Introduction

Reading literacy is defined as a complex competence encompassing not only the technical ability to decode written text but, above all, the ability to construct meaning from scientific texts, make inferences, and critically evaluate information (Snow, 2002; Rhodes et al., 2025). In science education, this competence is particularly important because students are required to work with textual and graphical representations, interpret experimental results, and formulate scientific conclusions based on evidence (OECD, 2019). Research has also shown that reading literacy is closely related to scientific literacy, which refers to students' ability not only to understand scientific concepts but also to apply them in new contexts and make informed decisions based on scientific evidence (Xie et al., 2023).

International large-scale assessments, such as PISA, systematically monitor the level of scientific literacy among 15-year-old students and confirm that Slovakia's performance remains around the OECD average compared with leading countries such as Finland and Canada, where reading and problem-solving strategies are effectively integrated into science education (OECD, 2019). Empirical studies have also identified specific instructional approaches that can foster the development of this competence, including explicit instruction in metacognitive reading strategies and teaching students how to interpret the structure of scientific texts (Xie et al., 2023).
Reading literacy in science education therefore includes the ability to:

- understand scientific texts (e.g., textbook passages, scientific articles, diagrams, and graphs);
- analyze and synthesize information from multiple sources;
- distinguish facts from interpretations or assumptions;
- interpret quantitative data presented in tables and diagrams;
- apply acquired knowledge to solve authentic problems.

Deficiencies in these competencies may limit students not only in academic settings but also in their ability to think critically about scientific issues encountered in everyday life. Therefore, the integration of reading strategies into science instruction is considered one of the key recommendations of contemporary science education and educational practice (Xie et al., 2023; Rhodes et al., 2025).

2 Relationship between Reading Literacy and Scientific Literacy

Reading literacy and scientific literacy are complementary competencies that mutually reinforce one another in science education. The ability to understand, critically analyze, and synthesize information from textual and multimodal sources is essential for acquiring scientific concepts and applying them in authentic situations (Rhodes et al., 2025; Xie et al., 2023).

A reciprocal relationship exists between reading literacy and scientific literacy. Reading literacy provides the cognitive and linguistic foundation for understanding scientific texts and arguments, whereas scientific literacy offers a meaningful context for developing advanced reading strategies focused on the interpretation of scientific information (Fang & Schleppegrell, 2010; Norris & Phillips, 2003).

Reading literacy involves the active construction of meaning through inferencing (drawing conclusions based on available information), comprehension monitoring, and the critical evaluation of information (Snow, 2002; Perfetti & Stafura, 2014). In the context of science education, this includes the ability to:

- understand scientific and factual texts, such as textbook passages, scientific articles, and laboratory reports;
- extract relevant information from graphs, tables, diagrams, and schematic representations;
- interpret scientific concepts, hypotheses, and argument structures presented in textual and multimodal formats.

Empirical studies indicate that students with well-developed reading literacy demonstrate higher levels of scientific text comprehension and perform better on complex science tasks (Cervetti et al., 2012; Xie et al., 2023). Conversely, poor reading skills are associated with superficial learning approaches and difficulties in formulating explanations and drawing conclusions in scientific contexts.

Scientific literacy refers to students' ability to locate, interpret, and evaluate scientific information, formulate and test hypotheses, and communicate the results of their investigations (OECD, 2019; Xie et al., 2023). At the same time, this process promotes the development of reading literacy by engaging students in activities such as:

- working with various types of texts, including scientific articles, experimental protocols, and research reports;
- critically evaluating evidence, arguments, and methodological approaches presented in scientific literature (Rhodes et al., 2025);
- writing their own scientific reports, arguments, and hypotheses.
- For example, when analyzing a scientific article on climate change, students not only acquire scientific knowledge but also develop higher-order metacognitive processes, such as identifying the main ideas, evaluating the credibility of sources, and constructively comparing alternative interpretations of the findings (Cervetti et al., 2012; Perfetti & Stafura, 2014).

3 How to Support the Mutual Development of Reading and Scientific Literacy?

Supporting the synergistic development of reading and scientific literacy requires systematic integration of activities that simultaneously enhance students' linguistic and cognitive competencies while fostering scientific thinking. Effective approaches include:

- Using authentic scientific texts and systematically analyzing them during science lessons, with an emphasis on identifying argument structures and scientific evidence (Rhodes et al., 2025; Alexander, 2020).
- Working with graphs, tables, and data visualizations, which promotes the simultaneous reading of texts and the inferential processing of data (Rhodes et al., 2025).
- Engaging students in discussions and argumentation activities on scientific topics, encouraging them to formulate and defend their interpretations based on textual and data sources (Perfetti & Stafura, 2014).
- Writing research reports and formulating hypotheses, enabling students to transform their understanding into their own written texts and scientific arguments (Xie et al., 2023).

Integrating these approaches into school practice not only improves students' achievement in science subjects but also strengthens their ability to critically evaluate scientific information in everyday life, thereby making a significant contribution to the development of lifelong literacy.

4 Research Design and Methodology

The study focused on analyzing the level of students' reading literacy in the context of science education, with particular emphasis on their ability to retrieve and process information from different types of sources. The empirical investigation was conducted using three comprehensive tasks that simulated authentic situations involving scientific texts, tabular data, and combined information sources.

4.1 Implementation of the Tasks in the Teaching Process

The tasks were designed as multidisciplinary activities integrating knowledge from biology, chemistry, physics, mathematics, and geography. Each task included an introductory scientific text followed by a variety of closed-ended and open-ended questions aimed at interpreting data, performing calculations, analyzing experimental situations, and explaining natural phenomena.

The first comprehensive task, Photosynthesis – The Basis of Life on Earth, was designed for students in Grades 6–7 of primary school. The task belongs to the topic of plant life and is primarily intended for biology lessons. Within the third educational cycle, it can be incorporated into thematic units dealing with plant and animal life processes and energy transformations in nature. The biological component focuses on the process of photosynthesis, the role of chlorophyll, the importance of carbon dioxide and water in the production of organic substances, and the significance of photosynthesis for food chains and ecosystem functioning.

In addition to biology, the task naturally integrates several other subjects. From a physics perspective, students encounter the concept of light as electromagnetic radiation and as the energy source required for photosynthesis. The chemistry component involves interpreting the chemical equation of photosynthesis and calculating the amounts of carbon dioxide consumed and oxygen released. Mathematics is applied through the interpretation of tables, calculations of mass changes, and solving simple numerical problems. The geographical dimension is reflected in interpreting the distribution of photosynthetic organisms across different regions of the world and explaining the importance of ecosystems in global biogeochemical cycles.

The second comprehensive task, Corrosion of Iron and Steel Structures, was designed for students in Grades 8–9 of primary school. It is primarily intended for chemistry lessons covering topics such as chemical reactions of metals, oxidation and reduction, and materials and their properties. The task focuses on the mechanism of metal corrosion, the influence of environmental conditions on corrosion rates, and methods of protecting metal structures.

Its multidisciplinary nature is also evident in its links to other school subjects. Mathematics is applied in calculating the percentage of metal mass loss and determining corrosion rates over time. Physics contributes concepts related to electrochemical processes and the principles of galvanic cells. Geography and social studies are incorporated through the analysis of the economic consequences of corrosion and the identification of industrial sectors in which corrosion causes significant financial losses.

The third comprehensive task, Cholesterol and Heart Health, was designed for students in Grades 8–9 of primary school. It is particularly suitable for biology lessons focusing on the human body, metabolism, and disease prevention. The task addresses the biological function of cholesterol, the differences between LDL and HDL cholesterol, the development of atherosclerosis, and the importance of a healthy lifestyle in preventing cardiovascular diseases.

This task is likewise strongly interdisciplinary. The chemistry component focuses on lipids and their functions in the human body. Mathematics is used in calculating percentage increases in cholesterol levels, estimating energy intake, and determining dietary fat consumption. Physics concepts are applied when explaining blood pressure as a physical quantity acting on the walls of blood vessels. Geographical aspects are reflected in the interpretation of regional differences in the prevalence of cardiovascular diseases worldwide.

The implementation of such comprehensive tasks in science teaching promotes active learning and supports students in integrating knowledge from different scientific disciplines. While solving these tasks, students learn to analyze texts, interpret data, perform calculations, and explain natural phenomena within broader scientific contexts. At the same time, they develop an awareness of the practical importance of scientific knowledge for everyday life, environmental protection, and personal health.

The questions accompanying the tasks were diverse and assessed multiple levels of students' knowledge and skills. They included multiple-choice questions aimed at identifying correct answers, completion and calculation tasks integrating scientific and mathematical skills, and matching tasks designed to assess conceptual understanding. The assessment also included true/false questions that examined students' understanding of relationships and open-ended questions requiring explanations of phenomena and the proposal of solutions. Some tasks combined data analysis and interpretation with brief written justifications. Overall, the tasks covered a broad range of cognitive processes, from remembering and understanding to application, analysis, and evaluation.

4.2 Research Objective

The main objective of the study was to identify students' level of mastery of the individual components of the information acquisition competency (information retrieval, selection, integration, and interpretation) and to analyze the typical errors students make when solving complex tasks in a science context.

4.3 Research Questions

Based on the research objective, the following research questions were formulated:

1. What is the level of students' success in solving tasks focused on information retrieval from texts, working with tables, and integrating information from multiple sources?
2. Which component of information acquisition competency presents the greatest difficulty for students?
3. What types of errors occur when students solve the individual tasks, and at which stage of information processing (retrieval, selection, integration, or interpretation) do these errors occur?

4. How does task complexity (simple versus integrated tasks) affect students' success?

4.4 Description of the Research Sample

The research sample consisted of 62 eighth-grade primary school students. A purposive sampling method was used, and all participants attended regular primary school classes.
The students were approximately 13–14 years old, corresponding to the lower secondary level of education. This age group was selected because students at this stage are expected to possess basic reading strategies while simultaneously encountering increasingly demanding scientific texts in science subjects.

The research sample constituted a homogeneous group in terms of educational level, enabling comparisons of students' performance across different task types and the identification of common difficulties in information processing within the target population.

4.5 Research Instrument

The research instrument was a test consisting of three comprehensive tasks, each comprising several sub-items designed to assess different aspects of reading literacy in a science context. The tasks were designed to assess:

- comprehension of continuous texts (information retrieval and comprehension);
- interpretation of non-continuous texts (tables and graphs);
- integration and interpretation of information from multiple sources.

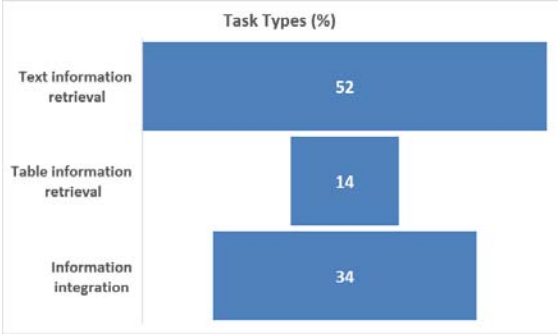
The study employed a mixed-methods research design, combining quantitative and qualitative approaches. The quantitative analysis focused on students' performance on the different task types and the percentage of correct responses. The qualitative analysis examined and categorized students' errors, identifying the stage of information processing—retrieval, selection, integration, or interpretation—at which failures most frequently occurred.

The proposed research design made it possible to comprehensively assess students' reading literacy through authentic tasks simulating real-life situations involving scientific information. At the same time, it provided detailed insights into students' problem-solving processes and identified the critical stages that represent the greatest barriers to effective information processing in science education.

5 Analysis of the Research Results

Based on the analysis of students' responses to the individual sub-tasks, three main categories of activities within the information acquisition competency were identified: (1) information retrieval from text, (2) working with tabular data, and (3) identifying and integrating information from multiple sources. These categories accounted for 52% of the tasks focused on text-based information retrieval, 14% of the tasks involving tabular data, and 34% of the tasks requiring the integration of information from multiple sources.

Figure 1. Distribution of Information Acquisition Task Types



Information Retrieval from Text
The first category included tasks focused on identifying specific information in a text, including both explicit and implicitly presented information, definitions of scientific concepts, and the selection of information according to specified criteria. The average success rate reached 83.76%, indicating the relatively low cognitive demand of these tasks. Nevertheless, students experienced difficulties with tasks requiring the identification of complex information consisting of multiple elements. In such cases, they often provided only partial answers and failed to identify all relevant information, particularly when multiple selection criteria had to be applied.

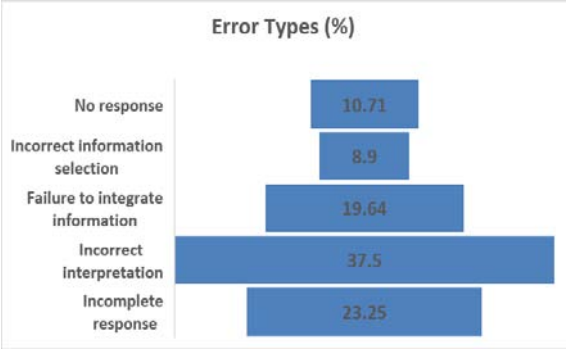
Working with Tabular Data
The second category consisted of tasks focused on retrieving information from tables as a specific form of data representation. This category achieved the highest success rate (93%), suggesting that students were relatively successful in directly locating information in structured formats. However, performance declined in tasks requiring the simultaneous identification of multiple data points or their integration with other information sources, indicating limitations in more complex information processing.

Integration of Multiple Sources of Information
The lowest success rate (71.43%) was recorded in the third category of tasks, which required students not only to identify relevant information but also to integrate and interpret it. These tasks represented a higher level of cognitive demand because they required the integration of multiple sources of information into a coherent whole. The results suggest that this stage of information processing presents the greatest challenge for students.

Error Analysis
To identify the sources of students' difficulties, a detailed analysis of incorrect responses was conducted. Incorrect responses accounted for 19.05% of all responses. Based on the nature of the errors, these responses were classified into five categories:

- No response (10.71%) – no answer was provided, most likely due to uncertainty or misunderstanding of the task.
- Incorrect information selection (8.9%) – identification of irrelevant or incorrect information despite working with the source material.
- Failure to integrate information (19.64%) – inability to combine multiple correct pieces of information into a coherent response.
- Incorrect interpretation (37.5%) – the most frequent type of error, resulting from misunderstanding the meaning of the identified information.
- Incomplete response (23.25%) – providing only part of the required information without addressing all aspects of the task.

Figure 2. Distribution of Error Types in Students' Responses



The analysis showed that failures occurred at different stages of information processing, ranging from information retrieval and selection to integration and interpretation. The predominance of errors in the categories of interpretation and information integration indicates that students' main difficulties lie not in retrieving information itself but in achieving a deeper understanding and processing of that information.

6 Discussion

The findings indicate that students' performance declines significantly as the cognitive demand of the tasks increases, highlighting the difference between solving simple and complex (integrated) tasks. Students achieved the highest scores on tasks based on the straightforward retrieval of explicitly presented information, such as locating specific data in tables, where no deeper processing was required. In contrast, the greatest difficulties were observed in tasks requiring the integration of multiple pieces of information, the establishment of relationships among them, and their subsequent interpretation. Such tasks involve higher-order cognitive processes, including inference, synthesis, and evaluation. This trend suggests that students have less developed skills for working with complex texts and solving tasks that extend beyond the level of basic comprehension. From a pedagogical perspective, these findings emphasize the need for the systematic development of higher levels of reading literacy, particularly through tasks that promote critical thinking and the integration of information from multiple sources.

The observed differences between students' performance on lower-order and higher-order tasks support current theoretical perspectives on reading comprehension. While students demonstrated satisfactory performance when retrieving explicitly stated information, considerably lower success rates were found in tasks requiring inference, integration, and interpretation. According to Perfetti and Stafura (2014), successful reading comprehension depends not only on decoding and vocabulary knowledge but also on the ability to construct coherent mental representations of text by integrating multiple sources of information. Similarly, Snow (2002) emphasizes that deeper comprehension requires readers to generate inferences and actively connect new information with their prior knowledge. The present findings are consistent with these theoretical assumptions, suggesting that students' difficulties arise primarily during higher-level cognitive processing rather than during basic information retrieval.

It is also important to consider the organizational conditions of the study, particularly the 30-minute time limit, which may have negatively affected students' performance on more demanding tasks, as these require more time for processing. This may have contributed to the higher frequency of incomplete responses or unanswered items, reflecting not only a lack of knowledge but also insufficient time to carefully consider and formulate a response.

7 Conclusion

The findings of this study indicate that students achieved the highest success rates on tasks focused on simple information retrieval, particularly from structured formats such as tables, confirming their ability to work with explicitly presented information. However, as the cognitive demand of the tasks increased, students' performance declined considerably. The greatest difficulties were observed in tasks requiring the integration, connection, and interpretation of multiple pieces of information.

The error analysis further revealed that the primary challenge was not information retrieval itself but rather the correct understanding and processing of information. This was reflected in the high proportion of errors related to interpretation and the failure to integrate information. The findings highlight the need for the systematic development of higher-order cognitive processes, particularly inference, synthesis, and critical thinking, which are essential for effective comprehension of scientific texts in science education. At the same time, the influence of organizational factors, such as the time limit, should also be considered, as it may have affected students' performance on more demanding tasks.

These findings are consistent with both national and international research. In Slovakia, Gavora (2012) identifies reading comprehension as a fundamental student competence, while Lapitková et al. (2015) and Held et al. (2011) emphasize its importance for the interpretation of scientific information and the development of scientific literacy. Similarly, Dobišová Adame et al. (2020) highlight the need to connect reading comprehension with the practical application of knowledge in science contexts.

Likewise, international researchers (Norris & Phillips, 2003; Phillips & Norris, 2009) argue that reading literacy is an integral component of scientific literacy and that understanding the language of science is essential for learning. Empirical studies (Dori et al., 2018; Cromley & Azevedo, 2007) demonstrate that the development of metacognitive strategies and text-based learning improves students' comprehension and academic achievement, while broader conceptions of scientific literacy (Laugksch, 2000; Guthrie, 2004; Snow, 2002) emphasize the importance of active information processing, motivation, and inferential reasoning.

From an educational perspective, these findings highlight the importance of systematically incorporating reading strategies into science instruction. Rather than focusing exclusively on factual knowledge, science teachers should provide students with regular opportunities to analyse scientific texts, compare information from different representations, and justify their conclusions using evidence. Such instructional approaches have been shown to improve both reading comprehension and scientific literacy (Cervetti et al., 2012; Xie et al., 2023). Moreover, integrating authentic scientific texts and inquiry-based activities into classroom practice may strengthen students' ability to transfer reading skills to complex scientific contexts (Rhodes et al., 2025).

Overall, the findings suggest that although students are proficient in basic information-processing tasks, greater emphasis should be placed on developing their ability to work with complex information, integrate information from multiple sources, and interpret it within broader contexts. These competencies represent a fundamental prerequisite for the development of both scientific literacy and reading literacy.

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Primary Paper Section: A

Secondary Paper Section: AM

GREEN PUBLIC PROCUREMENT AND GREEN INVESTMENT IN THE EUROPEAN UNION: A COMPARATIVE ANALYSIS OF FRANCE AND SLOVAKIA

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Abstract: This paper analyzes Green Public Procurement (GPP) as a strategic instrument of sustainable development in the European Union, with a comparative focus on France and Slovakia. It examines how environmental criteria are integrated into public procurement systems and how these processes contribute to green investment and market transformation. Using a qualitative comparative case study methodology, the research highlights differences in regulatory frameworks, institutional capacities, and implementation practices. France represents an advanced model characterized by strong legal obligations and rapid policy diffusion, while Slovakia demonstrates a transitional approach driven by local initiatives but constrained by systemic barriers. The findings suggest that the effectiveness of GPP depends not only on legislative frameworks but also on administrative capacity, professional expertise, and coordination mechanisms. The study contributes to the understanding of GPP as a key policy tool linking public expenditure with environmental objectives and sustainable economic transformation.proposes legislative and policy reforms aimed at strengthening the integration of Environmental, Social and Governance (ESG) principles into the Slovak public procurement framework. The proposed amendments are aligned with the European Green Deal, Regulation (EU) 2024/3005 on ESG ratings, and the broader objectives of sustainable public procurement within the European Union. The study emphasizes the role of ESG certification, green evaluation criteria, life-cycle costing, digital product passports, and mandatory sustainability indicators in increasing transparency, reducing greenwashing, and improving the environmental performance of public expenditure. The analysis further demonstrates that municipalities and regional governments can become strategic actors of ecological transformation by transitioning from the procurement of the cheapest products toward the procurement of solutions with the lowest environmental impact.

Keywords: GPP, Green Public Procurement, France, Slovakia, Sustainable development, EU funds,, Green Investment, European Union, ESG rating

1 Introduction

This paper analyzes Green Public Procurement (GPP) as a strategic instrument of sustainable development in the European Union, with a comparative focus on France and Slovakia.

Public procurement has become a central instrument of economic governance within the European Union, representing approximately 14–16% of GDP and nearly €1.8 trillion in annual expenditure (European Commission, 2021).

This significant purchasing power positions public authorities as key actors capable of influencing market dynamics and supporting the transition toward sustainability. In this context, Green Public Procurement (GPP) has emerged as a policy tool aimed at integrating environmental considerations into procurement processes.

GPP is defined as a process whereby public authorities procure goods, services, and works with reduced environmental impacts throughout their life cycle compared to conventional alternatives (European Commission, 2008). This approach reflects a broader shift from price-based procurement toward value-based decision-making, incorporating life-cycle costing, environmental externalities, and long-term sustainability objectives.

The importance of GPP is further reinforced by its connection to green investment strategies. By directing public spending toward environmentally sustainable solutions, governments can stimulate innovation, create new markets, and accelerate the diffusion of green technologies (OECD, 2023). However, despite its potential, the implementation of GPP varies significantly across EU Member States.

GPP influences investment decisions by creating demand-side incentives for environmentally friendly products and services. Public buyers can stimulate markets by prioritizing energy-efficient technologies, circular materials, and low-carbon infrastructure *(European Commission GPP, 2024).*

This paper aims to provide a comparative analysis of GPP implementation in France and Slovakia. Concerning technical and professional capacity requirements by enabling contracting authorities require ESG certification or ESG ratings issued by entities authorized by the *European Securities and Markets Authority (ESMA)*. Public contracts are awarded only to companies capable of demonstrating responsible governance, environmental risk management, and sustainable operational performance. The French SPASER model (Schéma de Promotion des Achats Socialement et Écologiquement Responsables) already requires major suppliers to demonstrate their environmental and social impact across the supply chain, thereby representing a benchmark for Slovak legislative reform.
These countries represent two distinct models: France as a highly institutionalized and policy-driven system, and Slovakia as a developing framework characterized by localized initiatives and structural challenges. The research seeks to answer the following question: *To what extent do institutional capacity and policy design influence the effectiveness of GPP in promoting sustainable development?*

2 Literature Review

The academic literature identifies GPP as a critical mechanism for aligning public expenditure with environmental objectives (Testa et al., 2016). Scholars emphasize that GPP operates as a demand-side policy instrument capable of influencing supply chains and fostering eco-innovation (Brammer & Walker, 2011). Internal Market & SMEs of standing sdandardized internal market issues. From an economic perspective, GPP promotes lifecycle costing approaches, shifting focus from initial price to long-term value. This encourages investments in innovation, particularly in sectors such as construction and transport, which account for a substantial share of procurement-related emissions. [5]. A central concept within GPP is lifecycle costing (LCC), which evaluates total costs over the product lifecycle rather than initial purchase price. This approach incentivizes investments in:energy efficiency, durability and recyclability, low-carbon technologies. *(European Environment Agency,2024).*

Several studies highlight the economic and environmental benefits of GPP. According to Albino et al. (2015), GPP contributes to reducing greenhouse gas emissions and resource consumption while simultaneously promoting competitiveness in green industries. Life-cycle costing is frequently identified as a key tool for ensuring cost-effectiveness, as it captures operational and disposal costs beyond the initial purchase price (Lundberg et al., 2015).

However, the literature also identifies persistent barriers to implementation. These include limited administrative capacity, lack of expertise, and legal uncertainty among procurement officers (Cheng et al., 2018).

In many cases, public authorities continue to prioritize the lowest price criterion, which undermines the adoption of environmentally sustainable solutions (Grandia & Voncken, 2019).

Comparative studies suggest that countries with strong regulatory frameworks and centralized coordination mechanisms achieve higher levels of GPP implementation (OECD, 2024). France is often cited as an example of a country with advanced GPP policies, supported by national action plans and mandatory environmental criteria (Ministère de la Transition écologique, 2022).

Regarding the description of procurement subject matter,a mandatory "green filter" would be introduced, applicable to at least 50% of annual procurement expenditure by municipalities and regional authorities. This proposal significantly exceeds the current Slovak threshold and aligns public procurement with European sustainability objectives. Mandatory measurable indicators should include Global Warming Potential (GWP), calculated as the maximum permitted level of kg CO2e per square meter in construction projects according to methodologies similar to the Dutch DuboCalc model; Life-Cycle Costing (LCC), including environmental externalities pursuant to Section 44 of the Public Procurement Act; and circularity requirements requiring a minimum 20% share of recycled materials in construction materials and asphalt.

In contrast, Central and Eastern European countries, including Slovakia, face challenges related to institutional capacity and policy enforcement (Klimovský & Nemec, 2020).

Studies suggest that in many EU countries, GPP accounts for less than 5% of total procurement, while leaders exceed 15% being high resolution GPP implementators. *(OECD, 2025)*

Recent European data indicate a growing uptake of sustainable procurement practices. According to European Environment Agency indicators, 63% of surveyed European cities and regions incorporate circular or green criteria into procurement, compared to 53% in 2020 . (European Environment Agency ,2024)

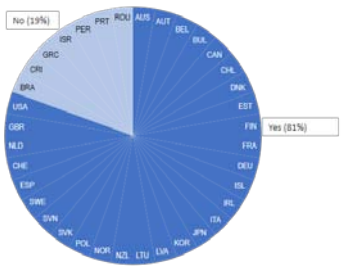
Additionally, OECD data show that 69% of countries have established quantitative GPP targets, reflecting increasing institutionalization (OECD, 2025).
Implementation of the Digital Product Passport (DPP) is dated beginning in 2026, contracting authorities should be required to integrate Digital Product Passport requirements pursuant to the Ecodesign for Sustainable Products Regulation (ESPR) into procurement procedures involving electronics, batteries, and textiles. The DPP mechanism would significantly increase traceability, prevent greenwashing practices, and enable municipalities to monitor the sustainability profile and life-cycle characteristics of procured goods.

3 Methodology

This study employs both quantitative statistical a qualitative comparative case study approach, focusing on France and Slovakia as representative cases of different stages of GPP development. The methodology is based on:

- Analysis of policy documents and legislative frameworks
- Review of academic literature and OECD reports
- Comparison of Slovak and French GPP Policy in the EU27
- Comparative current case studies analysis
- Correlation between GPP share and Eco-innovation indexes

Figure 1 Analysis of countries using GPP tool



Source. OECD Perspective,2021

Examination of case studies at the national and municipal levels
The selection of cases is justified by their contrasting institutional environments. France represents a mature system with strong regulatory enforcement, while Slovakia provides insight into the challenges of implementing GPP in a transitional context.

The research adopts a descriptive and analytical approach, aiming to identify key factors influencing the effectiveness of GPP, including institutional capacity, policy design, and stakeholder engagement.

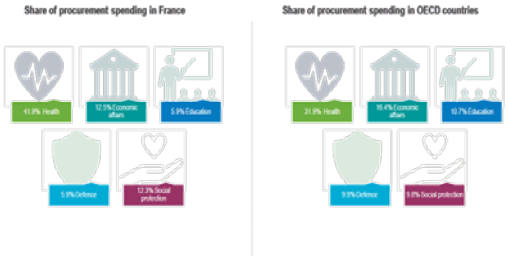
4 Research and Case Study Analysis

4.1 France: Institutionalized GPP Model

France has developed one of the most comprehensive GPP frameworks in the European Union. The Climate and Resilience Law (2021) mandates the inclusion of environmental criteria in all public contracts by 2026.

The National Plan for Sustainable Procurement (PNAD) 2022–2025 further reinforces these objectives, setting targets for the integration of environmental and social considerations.

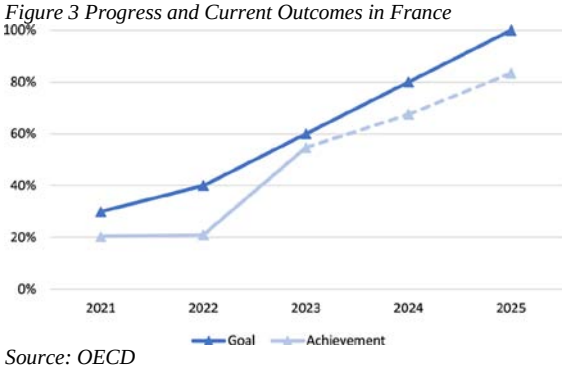
Figure 2 Regulatory Framework



Source: OECD

Empirical data demonstrate significant progress. The share of contracts including environmental criteria increased from 20.4% in 2021 to 54.7% in 2023 (OECD, 2024). This growth reflects strong political commitment and institutional support.

Figure 3 Progress and Current Outcomes in France



Source: OECD

However, challenges remain. Surveys indicate that only 30% of procurement officials have received training in GPP, highlighting the need for capacity building (OECD, 2024). Furthermore, the complexity of integrating environmental criteria across procurement stages requires multidisciplinary expertise.

4.2 Slovakia: Transitional GPP Model

In Slovakia, GPP implementation is less advanced and largely voluntary. National action plans provide guidance, but enforcement mechanisms remain limited. As a result, the adoption of GPP varies across regions and institutions.

The most significant progress can be observed at the municipal level, particularly in Bratislava. The city has implemented responsible procurement practices, including the use of eco-certified products and energy-efficient infrastructure. Projects such as LED street lighting modernization demonstrate the

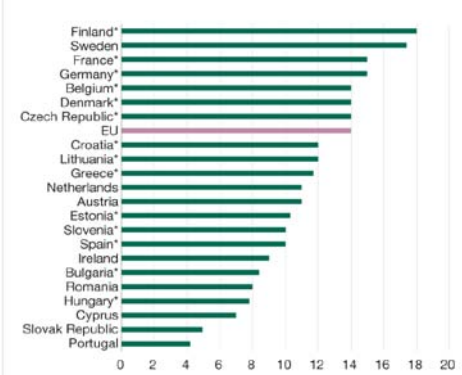
potential of GPP to reduce environmental impacts and operational costs.

Despite these successes, systemic barriers persist. These include limited financial resources, lack of expertise, and a strong preference for lowest-price evaluation criteria *(Klimovský & Nemec, 2020)*. These factors constrain the broader adoption of GPP across the country.

Varied among countries. Slovak academic literature, actually *(Nemec- Meričková, 2019*) highlights that while legal frameworks exist, implementation gaps persist. Compared to EU leaders, Slovakia's GPP adoption is still in a developmental phase, with pilot projects rather than systemic application. *(Nemec, 2018)*

Moreover, GPP contributes to market transformation by reducing risks for private investors. Stable public demand signals increase the viability of green technologies, thus crowding in private capital. *(European Commission, Internal Market,2025)*

Figure 4 EU-27 GPP expenditure as Percentage of GDP



Source: Intereconomics, Green Deal Toolbox.Available online: https://www.intereconomics.eu/contents/year/2022/number/3/article/green-public-procurement-a-neglected-tool-in-the-european-green-deal-toolbox.html

As Figure 4 shows in the EU the GPP understanding level is slightly different in different regions slowing down in Slovakia and V4 countries.

4.3 EU27 context EU GPP Uptake

OECD sources represent very wellknown best- practies. Although, comprehensive Eurostat-wide harmonized data on GPP uptake remain limited, proxy indicators such as circular material use rates (11.8% in 2023 EU average) and green investment flows suggest a positive correlation between procurement policies and sustainability outcomes.*(OECD,2025)*

Table 1. EU27 GPP Uptake (Estimated Range)

Country Group	Estimated Share of GPP in Total Procurement (%)	*Correlation between GPP share* (%) *in Total* ***Eco-innovation*** *index* ***SDI***
Leaders (Netherlands, Sweden, Denmark)	10–15%+	*0.7*
Moderate adopters (Germany, France, Austria)	5–10%	*0.55*
Emerging adopters (Slovakia, Hungary, Bulgaria)	<5%	*0.23*

Source: TED-based estimates, OECD

Based on the calculations the European Commission made available progression reports, entitled Government at a Glance, two indexes were raised and compared with regard to the estimated share of GPP in Total Procurement as a success rate.

Sustainability Development Indicator statistical measures used to assess progress toward long-term sustainability goals, focusing on economic, social, and environmental health. They serve as critical tools for policymakers to track changes, identify areas needing action, and communicate sustainability.

Sources provide relevant *Eco-innovation index* measuring green innovation performance and from Eurostat's Sustainable Development Indicators (SDIs), the time series until 2022 are updated. Available https://www.sustainabledevelopmentindex.org/time-series could provide responsible secondary data for the quantitative research.

Table 1 is classifying European countries into three groups based on how much of their public procurement is estimated to be "green public procurement" (GPP)—meaning government purchasing that considers environmental criteria (e.g., low-carbon goods, energy-efficient services, sustainable materials).

Country Group Countries clustered by similar levels of GPP adoption. Estimated Share of GPP in Total Procurement (%) is the approximate proportion of all government purchasing that is "green".*(Nilsson -Lewis, 2023).*

Table 2. OECD Indicator on GPP Policy Adoption (2024)

Country Group	OECD GPP *Policy Adoption Value* (%)(%)	*Correlation between GPP Policy Adoption Value* (%) *in T* ***Eco-innovation*** *index* ***SDI***
Countries with GPP targets	*69%*	*0.77 (high)*
Countries with mandatory GPP requirements	*41%*	*0.59 (moderate)*
Countries with both)	*20%*	*0.89 (very high)*

Source:OECD

Table 2 above shows a clear gradient of policy maturity in green public procurement across Europe. Northern and some Western European countries are ahead. Central Western Europe is mid-transition, while several Central- Eastern European countries are still in early adoption stages. *(Publication Office, EU, 2012].*

Eurostat proxy indicators in *Table 3* are EU-wide harmonised statistical measures compiled from national data sources and updated mainly on an annual basis, usually with a reporting delay of about 1–2 years due to validation and harmonisation processes.*(Eurostat, Circular economy,2025)*

Table 3 .Eurostat Proxy Indicators (Sustainability & Circularity)

Country Group	Value (Latest) (%)	Correlation between GPP Policy Adoption Value (%) in T Eco-innovation index
Circular material use rate	11.8%	0.77 (high)
Public procurement share of GDP	14–19%	0.59 (moderate)
Green investment growth trend	Increasing	0.89 (very high)

Source: Compiled from Eurostat and EU reports Circular Economy https://ec.europa.eu/eurostat/web/circular-economy

The next sections examine quantitative case study analysis, evidence based measured on institutional level.

5 Research Hypothesis

Based on the literature and preliminary analysis, the study formulates the following hypothesis:

H1: Countries with stronger regulatory frameworks and higher institutional capacity achieve more effective implementation of Green Public Procurement and greater integration of environmental criteria in public contracts.
H2: Countries with greater integration of GPP analyses the role of GPP in shaping investment patterns, leading to rapid markt transformation.
(compared to selected EU Member States, and highlights the Slovak context using French case studies)

The comparative analysis confirms the research hypothesis. France demonstrates that strong legislative frameworks and political commitment can significantly accelerate the adoption of GPP. The mandatory inclusion of environmental criteria creates clear incentives for public authorities and suppliers, leading to rapid market transformation.

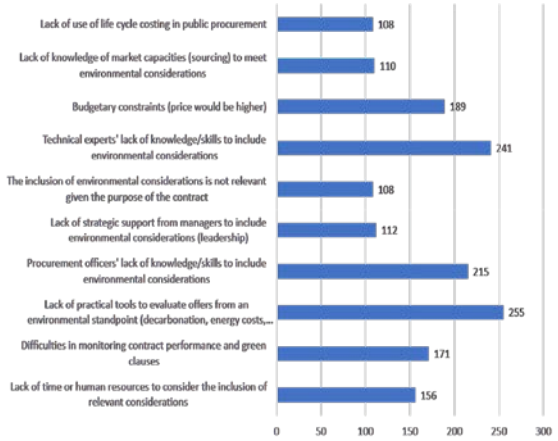
To test H2 academically, economists can construct a panel dataset of EU Member States (including Slovakia and France) measuring the intensity of Green Public Procurement adoption alongside indicators of investment flows and market transformation.

Using econometric techniques such as fixed-effects or difference-in-differences models, they can estimate whether higher GPP integration significantly correlates with shifts in private and public investment patterns.

6 Results

Comparative case studies—especially drawing on France's advanced GPP implementation—can provide qualitative evidence of causal mechanisms, while Slovakia offers a contrasting, emerging context. Robustness checks (e.g., controlling for GDP, regulatory quality, and EU funding absorption) help ensure the observed effects are not spurious.
Countries with stronger GPP integration tend to influence investment behavior and accelerate market transformation, with France illustrating mature impacts and Slovakia showing developing dynamics.

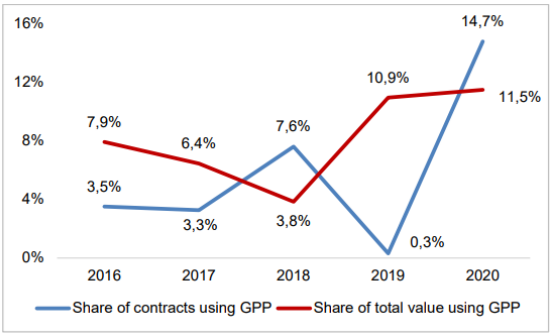
Figure 5 Key Challenges in France GPP



Source: OECD

In contrast, Slovakia illustrates the limitations of voluntary approaches. While local initiatives demonstrate the feasibility of GPP, the absence of strong enforcement mechanisms limits its systemic impact. This finding aligns with previous research emphasizing the importance of institutional capacity and policy coherence.

Figure 6 Use of GPP in Public Institutions in Slovakia



Source: GPP in Slovakia from Slovak Environment Agency

Effective monitoring and evaluation are essential to fully realize the advantages of Green Public Procurement (GPP), as a lack of tracking mechanisms can severely hinder successful implementation.

In Slovakia, the Slovak Environment Agency monitored the 2016–2020 National Action Plan for GPP through online surveys of public institutions.

The analysis also highlights the role of professional expertise. In both countries, the lack of training and technical knowledge among procurement officials represents a major barrier. This suggests that capacity building is a critical factor for successful implementation.

Furthermore, the study underscores the complementary relationship between GPP and green investment. In France, public procurement acts as both a direct investment channel and a market-shaping mechanism. In Slovakia, its impact is more limited but still significant at the local level.

5 Discussion

For municipalities and local governments, the proposed reforms represent a transition from procurement focused primarily on the lowest purchase price toward procurement emphasizing the lowest environmental and social impact.

Table 4 Sectors and proposed mandatory GPP sustainability indicator

Sector	Proposed Mandatory Sustainability Indicator
Buildings	Energy certification class A0 and minimum 30% natural construction materials.
Vehicle Fleet	100% low-emission vehicles in public transport renewal procedures in accordance with the Clean Vehicles Directive.
Services	Mandatory social inclusion criteria and ESG certification of suppliers.

Source: own preparation

The transposition of these proposed amendments would align Slovak public procurement legislation with the current European Green Deal agenda and with emerging EU sustainability regulations.

The reforms would strengthen institutional transparency, improve accountability in the allocation of public resources, and ensure that public finance after 2026 is directed toward economic actors capable of demonstrably reducing environmental impact and supporting sustainable development objectives.

7 Conclusion

Green Public Procurement represents a key instrument for achieving sustainable development and climate objectives in the

European Union. The comparative analysis of France and Slovakia demonstrates that while GPP has significant potential, its effectiveness depends on institutional capacity, regulatory frameworks, and professional expertise.

France illustrates the benefits of a comprehensive and mandatory approach, while Slovakia highlights the challenges of decentralized and voluntary implementation. These findings suggest that strengthening institutional capacity, improving training, and enhancing policy coordination are essential for maximizing the impact of GPP.

Ultimately, GPP should be understood not merely as a procurement tool but as a strategic mechanism for driving systemic change, linking public expenditure, green investment, and market transformation.

While its uptake is increasing, further harmonization, mandatory reporting, and capacity building are necessary to unlock its full potential. Strengthening GPP—especially in countries like Slovakia—can significantly enhance sustainable investment flows and contribute to achieving EU climate and circular economy objectives

Despite its potential, several barriers persist: Data limitations of our panel data are found in the lack of standardized EU-wide statistics via fragmentation through different national approaches and administrative burden; in the future, insufficient incentives should be removed.

Policy Recommendations include introducing mandatory EU-wide GPP reporting, strengthening capacity building in CEE countries, expanding lifecycle costing methodologies and integrating GPP with EU taxonomy and sustainable finance. Green Public Procurement represents a powerful yet underutilized instrument for driving sustainable investments in the EU.

While progress is evident, particularly in leading Member States, significant disparities persist. Strengthening GPP implementation—especially in countries like Slovakia—will be crucial for achieving EU climate and sustainability objectives.

This paper was prepared within the project STICS 09I02-03-V01-00011 supported by the EU from Recovery and Resilience Plan Funding, Call ID: 09I02-03-V01 TIC Slovakia

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Primary Paper Section: A

Secondary Paper Section: AH, AE

THE DEVELOPMENT OF ADMINISTRATIVE DIVISION AND REGIONAL IDENTITY IN SLOVAKIA

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Abstract: One of a multiple person's identities is their sense of belonging to the region which they come from, i.e., a regional identity. In this paper, we aim to analyze the development of Slovakia's administrative division and its impact on the regional identity of Slovak population. The most important factor in the formation of a regional identity was how long a region had existed. The second factor appears to be the size of the territory, as the so-called "major regions" are still used in a regional identity, even thirty years after their dissolution. The third factor is linguistic and cultural distinctiveness, which is more dominant mainly in the peripheral areas (the Záhoráci, the Gorali, and the dialects of Eastern Slovakia).

Keywords: region, regional identity, administrative division

Introduction

Every person identifies themselves on various levels. They may identify themselves professionally, socially, culturally, ethnically, and religiously. One aspect of a person's identity is their affiliation with the region from which they come—that is, their regional identity. In this paper, we aim to analyze the evolution of Slovakia's administrative divisions and their impact on the regional identity of Slovakia's population. We will examine the duration of individual administrative divisions as well as the geographical size of each region. The basic assumption is that regions that were larger and existed for longer periods left a greater imprint on the regional identity of the population.

1. The Historical Development of Regions in Slovakia

Throughout the development of the administrative division in Slovakia, several territorial units have come and gone. Chronologically, these were counties – "komitáty", "stolice", "župy", districts and regions. In Slovak historiography, there is a dual terminology regarding the nomenclature of these territorial units. The first group of historians refers to "župy" throughout their entire development from the Middle Ages to 1945. The second group of historians distinguishes between three terms based on the nature of these territorial units: up to the 13th/14th century, we refer to royal counties "kráľovské komitáty"; from the 13th/14th century to 1849, we refer to counties "stolice"; and for the periods 1849–1928 and 1940–1945, we refer to counties "župy". In this article, we will use the terminology from the second group, as we believe it more accurately describes reality.

1.1 Counties – "komitáty" (10th–13th/14th centuries)

Counties likely began to emerge at the end of the 10th century during the reign of Gejza (997–1000) and during the reign of Stephen I (1000–1038). They built upon the castle system established in Great Moravia and in the Transdanubia region.
In Slovakia, around the year 1000, the following counties likely already existed: Bratislava, Moson, Ráb, Komárno, Esztergom, Nitra, Novohrad (including the later Hont), and Turňa. Other counties were established roughly as follows: at the beginning of the 11th century: Tekov County, Zemplín County, the county of "comitatus Novi Castri" (later Abov, Šariš, and Heveš); in the 11th century: Hont County (separated from Novohrad County) and Uzh County; at the end of the 11th century: Trenčín County, Gemer County (established no later than the beginning of the 12th century); in the 12th century: Zvolen County (including Liptov, Orava, and Turiec); in the second half of the 12th century: Spiš County; in the first half of the 13th century: Šariš County (separated from Novi Castri County); in the second half of the 13th century: Abov County (a new name for the Novi Castri county). In addition, there were numerous small so-called border counties whose role was to protect the borders (in Slovakia, for example, Hlohovec). The counties were royal property and were divided into castle districts. At the head of each county stood a county governor (comes) appointed by the king. The county governor performed administrative, judicial, military, and economic functions. The counties ceased to exist with the establishment of the counties "stolice" (Žudel, 1984).

Map 1: Counties in Slovakia in the 13th century.

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_01.png

1.2 Counties – "stolice" (13th–14th centuries – 1848)

In the 13th century, royal power began to decline. Particularly during the reign of Andrew II (1205–1235), royal estates steadily diminished as a result of an ill-advised policy of royal grants to secular and ecclesiastical feudal lords. This caused concern among social classes dependent on the castle system, particularly among the royal servants. The royal servants feared that, due to the growing power of the magnates, they would fall under their control, and they compelled King Andrew II to issue the Golden Bull, which prohibited the donation of entire counties. But even the new monarch, Béla IV (1235–1270), was unable to halt the process of decay; he tried in vain to revise his father's policy of land grants. Consequently, the royal vassals began efforts to transform the royal counties into a new institution that would protect them from the magnates. In the 1230s, they gained judicial autonomy, which marked the first step toward the formation of the gentry councils. A royal decree of 1267 strengthened the position of the gentry and allowed nobles to participate in the annual judicial assembly in Stoličný Belehrad (Žudel, 1984). Royal decrees from 1290 and 1298 enshrined in law the nobility's right to elect four officials, who became representatives of self-government in the counties – "komitáty", thereby transforming them into counties – "stolice" (Žudel, 1990).

The transformation of counties – "komitáty" into counties – "stolice" proceeded unevenly in Slovakia. By the end of the 13th century, the counties "stolice" of Abov, Bratislava, Gemer, Hont, Komárno, Novohrad, Esztergom, and Zemplín had been established. In the early 14th century, Spiš and Turňa counties "stolice" were established, followed by Uh; and in the first half of the 14th century, Nitra, Šariš, Tekov, Trenčín, Liptov (separating from Zvolen County), Turiec (separating from Zvolen County), and Zvolen. Second half of the 14th century: Orava (became independent from Zvolen County). The county "stolice" boundaries were finalized in the 15th century. From the 14th century until 1802 (with the exception of 1785–1790), the following 21 counties – "stolice" existed in Slovakia: Abov, Bratislava, Gemer, Hont, Komárno, Liptov, Mozson, Nitra, Novohrad, Orava, Esztergom, Ráb, Spiš, Šariš, Tekov, Trenčín, Turiec, Turňa, Uzh, Zemplín, and Zvolen. In 1802, Malohont was definitively separated (previously, from 1786 to 1790, during the Josephine reforms of Emperor Joseph II) from the Hont County "stolica" (from which it was, however, separated by the territory of the Novohrad County) and merged with the Gemer County to form the Gemer-Malohont County "stolica". The individual counties were divided into so-called district offices (usually four). The highest self-governing bodies of the counties – "stolice" were the county assemblies. (Bačík, 2022).

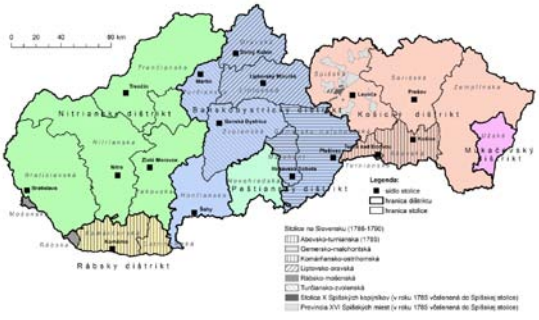
In addition to the counties – "stolice", certain towns and provinces in Hungary also enjoyed special status. In Slovakia during the modern era, these included, in particular: in Spiš—The Province of XXIV Spiš Towns, The Province of XIII Spiš Towns, and The Province of XVI Spiš Towns. Free royal towns and mining towns were not subject to the administration of the counties "stolice" (Bačík, 2022).

Map 2: Counties – "stolice" in Slovakia from the 14th Century to 1848.

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_02.png

1.3 The Josephine Reforms (1785–1790)

In 1785, a territorial reorganization was carried out in the Habsburg Monarchy by decree of Emperor Joseph II with the aim of streamlining state administration, reforming noble self-government, and establishing an absolutist and centralist form of government. Hungary, Croatia, and Slavonia were divided into 10 districts "dištrikty", each comprising 4–5 counties "stolice". The districts – "dištrikty" were headed by commissioners appointed by the monarch, and the counties stolice" under their jurisdiction were administered by deputy governors appointed by the monarch. Three districts – "dištrikty" were established in the territory of present-day Slovakia: Nitra (comprising the former counties of Pressburg, Nitra, Trenčín, and Tekov), the Banská Bystrica District (comprising the former Turčiansko-Zvolen, Hont, Gemer, and Liptov-Orava counties), and the Košice District (comprising the former Spiš, Šariš, Abov-Turňa, and Zemplín counties). The reform met with resistance, and Joseph II revoked it shortly before his death. The districts were abolished on May 1, 1790, and during the course of 1790, the territorial administrative division reverted to its pre-1785 state (Encyclopaedia Belliana, 2013).
Map 3: Districts – "dištrikty" in Slovakia - The Josephine Reform, 1785–1790.



Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_03.png

1.4 Bach's Absolutism, 1849–1860

After the revolution had been supressed in the second half of 1849, a military dictatorship—known as Bach's absolutism—was established throughout Hungary. The counties "stolice" were dissolved and they were replaced by state administrative units—counties "župy". In 1850, after the situation had stabilized, the military dictatorship was replaced by a provisional civil administration known as the Geringer Provisional Government, which was succeeded by a permanent government in 1853. Hungary was divided into five civil districts "dištriktov", which, however, did not correspond to the Josephine districts. Within Slovakia, with the exception of small areas around Bratislava, two districts "dištrikty" were established, with their seats in Bratislava and Košice. At the county "župy" level, the most significant change was the establishment of the Upper Nitra and Lower Nitra counties "župy"; similarly to the Josephine Reform, smaller counties "župy" were merged, though to a lesser extent. This administrative division was abolished in 1860 when the monarch renounced absolutism and the pre-revolutionary borders were restored (Bačík, 2022).
Map 4: Districts "dištrikty", 1850–1860, at the national level: Hungary

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_04.png

1.5 The County "župa" System (1867–1922)

The period between 1860 and 1863 was a time of political uncertainty. During this period, an attempt was made to establish self-governing counties "župy", but this could not be achieved within such a short time period. The establishment of self-governing counties "župy" did not occur until after the Austro-Hungarian Compromise of 1867, when a constitutional monarchy was established. A total of 63 counties "župy" were created throughout the territory of Hungary. With a few exceptions, no significant changes occurred within Slovakia. The Turnianska County "župa" was temporarily abolished, and its definitive dissolution took place in 1882. At this stage, the boundaries of the districts were also already recorded (Žudel, J., 1993). Minor changes to county "župy" boundaries occurred between 1882 and 1888. During this period, the Province of XVI Spiš Towns was also dissolved. The towns were not spared further significant changes. In 1870, a reform of municipal administration was carried out (Municipal Law No. 42/1870), under which the rights of free royal towns were abolished and 24 municipal towns were established; like the free royal towns, these did not fall under the jurisdiction of the counties "žúp". This autonomy was abolished, with the exception of four cities, by Act No. 20/1876. Only Bratislava, Košice, Komárno, and Banská Štiavnica remained as municipal cities. In 1886, the Municipal Act was amended (No. 21/1886), as was the Municipalities Act. Under this legislation, municipalities were divided into towns with an established municipal council, large municipalities, and small municipalities (Malý, K., Sivák, F., 1992). Toward the end of the 19th century, changes also occurred in the organization of civil registries, specifically with the introduction of civil state registries. After the establishment of the Czechoslovak Republic in October 1918, a very important task was the demarcation of state borders. The most problematic area was the southern border with Hungary, which was established by the Treaty of Trianon on June 4, 1920. Slovakia continued to be divided into counties "župy" and four municipal cities, although the borders of the border counties "žúp" were altered. The southern borders divided the counties of Rábska, Komárňanská, Ostrihomská, Hontianska, Novohradská, Gemersko-malohontská, Abovsko-turnianska, and Zemplínska. Smaller parts of the Ráb and Esztergom counties were annexed to the Komárno County, and a part of the Uzh County was annexed to the Zemplín County "župa", thereby reducing the

number of counties "žúp" by two. The municipal cities during this period were Bratislava, Košice, Komárno, and Banská Štiavnica with Banská Bela. The counties "župy" were further subdivided into 95 district administrative units and 30 towns with established municipal councils, which were: Banská Bystrica, Bardejov, Brezno, Gelnica, Jelšava, Svätý Jur, Kežmarok, Kremnica, Levice, Levoča, Lučenec, Modra, Nitra, Nové Zámky, Pezinok, Poprad, Prešov, Rimavská Sobota, Rožňava, Sabinov, Skalica, Spišská Belá, Spišská Nová Ves, Spišské Podhradie, Spišské Vlachy, Trenčín, Trnava, Zvolen, Ružomberok, and Žilina. In 1920, the border with Poland was adjusted, resulting in the cession of parts of Upper Orava and Northern Spiš (Bačík, 2022).

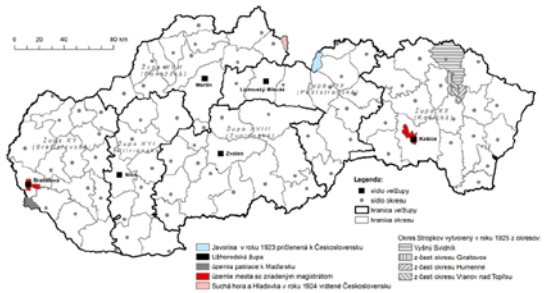
Map 5: 1867–1922, national level: Austria-Hungary

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_05.png

1.6 Czechoslovakia – Great Counties "veľžupy"(1923–1928)

The new county system took effect on January 1, 1923. Slovakia was thereby divided into six counties "župy", which were called great counties "veľžupy". This marked a significant turning point in the history of Slovakia's territorial administration, namely the abandonment of the traditional natural regions that had functioned, with some limitations, for approximately 900 years. This was very important, as there was no return to the traditional regions even in subsequent periods.

Map 6: Great Counties (1923–1928)



Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_06.png

The formation of the great counties was most influenced by the old counties "župyy" with distinct natural boundaries, and the influence of the former office district was also significant (especially in defining the boundaries of the Bratislava and Nitra great counties). In addition to the traditional regional centers of Bratislava, Nitra, and Košice, Zvolen was given priority over Banská Bystrica—which had been the center of Zvolen County "župa" since the 18th century—in the Zvolen Great County; Martin was given priority over Trenčín in the Považie Great County; and Liptovský Mikuláš became the center of the Podtatranská Great County. The Great Counties were divided into 79 districts pursuant to Decree No. 290/1922, which only partially corresponded to the former office districts; these became the basis for the districts that existed, with minor changes, until 1960. At the same time, the special status of towns with a magistrate and the status of municipal towns were abolished during this period. Only two cities, Bratislava and Košice, were granted the status of cities with a regulated magistrate. Given that this county "župa"system was established only within the territory of Slovakia, it was a provisional arrangement (Bačík, 2022).

1.7 The Provincial Administration "krajinské zriadenie" in Czechoslovakia from 1928 to 1938

On July 1, 1928, the provincial administrative system was established. This significantly simplified and unified the complex political administration in Czechoslovakia. The counties "župy" were abolished, but the districts remained unchanged, with a few exceptions. There were 79 districts in Slovakia. During this period, the districts of Liptovský Hrádok and Žiar nad Hronom were abolished. The head of province was based in Bratislava and administered the entire territory of Slovakia. On June 27, 1936, a branch office was established in Košice to serve the districts of eastern Slovakia. During these 10 years, the district boundaries remained relatively stable, with only a few exceptions. The status of Bratislava and Košice did not change; they were the only cities in the country of Slovakia with an established municipal government (Bačík, 2022).

Map 7: The Provincial Administration and Districts, 1928–1938

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_07.png

1.8 The Period of the Slovak State (1940–1945)

As a result of the Vienna Arbitration on November 2, 1938, Slovakia lost its southern districts, and on March 14, 1939, the Slovak State was proclaimed, marking the first time in history that Slovakia became an independent state. From January 1, 1940, the system of great counties "velžup" was reinstated, with revised boundaries: Bratislava (regional capital: Bratislava), Trenčín (regional capital: Trenčín), Nitra (regional capital: Nitra), Pohronie (regional capital: Banská Bystrica), Tatra (regional capital: Ružomberok), Šariš-Zemplín (regional capital: Prešov). New districts were established: Dobšiná, Hnúšťa, and Lovinobaňa; as a result of the Vienna Arbitration, the number of districts was reduced from 77 to 60 compared to the previous regional system (Bačík, 2022).

Map 8: Great Counties in Slovakia, 1940–1945

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_08.png

1.9 The Establishment of Regions "krajov" from 1949 to 1960

After the restoration of Czechoslovakia in 1945, the districts were reinstated as they had been in 1938. The territorial administrative organization during this period was two-tiered, with the first tier consisting of cities and municipalities and the second tier consisting of districts. After the communist regime came to power in 1948, a centralized three-tier system of national committees was introduced, with no form of self-government in place until 1990. On February 1, 1949, regional administrative units were reestablished under a new name—regions. Six regions and 92 districts were established in Slovakia. The number thus increased from 77 to 92. The most significant changes were recorded in the Banská Bystrica Region "kraj". Another interesting fact was the abolition of the category of statutory cities. For the first time in history, Žilina was elevated to the status of a regional "krajské" center. Another important fact is that all regional capitals were also urban districts (Slavík, V., 1997).

Map 9: Regions "kraje" and Districts from 1949 to 1960

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_09.png

1.10 Major Regions "kraje", 1960–1990

The emergence of this phase is exceptional in nature, as the reform took place despite the fact that no fundamental change in the political regime had occurred. Instead of the six regions from the previous phase, three large regions were established, and the number of districts was reduced to one-third, totaling 33. In 1968, the status of Bratislava as the capital and an independent territorial unit at the regional level was amended, making Bratislava, as the capital, the fourth region as well.

In the period that followed, some districts were reorganized due to their unusually large size, and four new districts were created: Veľký Krtíš, Stará Ľubovňa, Svidník, and Vranov nad Topľou. Another change at the district level took place on July 1, 1969, when the Košice District was divided into the Košice-City District and the Košice-Rural District. This phase lasted until 1990, making it the longest phase of territorial administration during the existence of the Czechoslovak state (Bačík, 2022).

Map 10: Regions "kraje" and Districts in Slovakia, 1960–1990

Source: http://www.sodbtn.sk/obce2/obr_historia/mapa_10.png

1.11 The Current Territorial and Administrative Structure of Slovakia (since 1996)

In 1990, the regions "kraje" were dissolved. They were reestablished in 1996, and their number was increased to eight. Slovakia was thus divided into 8 regions "krajov" and 79 districts, including 9 urban districts (Bratislava – 5, Košice – 4). The established regions are named after their regional capitals, with the 7 largest cities selected as regional capitals, along with Trenčín, the 9th largest city. The main quantitative criterion for selecting districts was a population threshold of 30,000. Of the established districts, nowadays 5 do not meet this threshold (Banská Štiavnica, Medzilaborce, Krupina, Poltár, Žarnovica) (Bačík, 2022).

Map 5: Map 11. Regions "kraje" and Districts in Slovakia, 1996–Present

http://www.sodbtn.sk/obce2/obr_historia/mapa_12.png

2. The Development of Administrative Divisions and Regional Identity in Slovakia

2.1 Overall Assessment of the Stages of Slovakia's Administrative-Territorial Division

A historical overview of the individual stages confirms a strong correlation between changes in territorial administration and political changes within a given state entity. With one exception, all changes in territorial organization occurred following a significant prior political and social upheaval (the revolutionary years of 1848–49, the Austro-Hungarian Compromise of 1867, the dissolution of Austria-Hungary and the establishment of Czechoslovakia in 1918, the Vienna Arbitration of 1938, World War II, and the onset of the communist era in 1948). The exception was the change in territorial organization in 1960, when efforts to implement larger administrative units based on the Soviet model were carried out (Slavík, V., 1997b).

In Hungary, or rather Austria-Hungary, the systems of territorial administration were characterized by a high degree of stability; in contrast, during the Czechoslovak era, there were frequent changes in the various models. Throughout its history, Slovakia was only once organized as a single territorial administrative unit, namely under the provincial administration from 1928 to 1938.

The time periods of the various stages of territorial administration show that there was usually a transitional period between the different systems, during which a new system of administration was being established.

Some administrative regions that developed within the territory of Slovakia during the Hungarian Empire extended beyond the current borders of Hungary, and the administrative centers of these regions were located outside the territory of Slovakia. These were the counties "stolice/župy" in southern Slovakia and the Uzh County"stolica/župa" in eastern Slovakia. (See Table 1.) The centers of the oldest administrative regions were located in castles. Later, in the 17th century, administrative functions began to shift to towns, a trend reinforced by the construction of administrative buildings.

While the traditional historical regions had relatively stable centers, the regions in southern Slovakia lack significant historical centers, precisely because the administrative centers of these territories are located outside Slovakia, as mentioned earlier (Slavík, V., 1997b).

Table 1: The area of the counties "župy" and the proportion of their territory within Slovakia

County "župa"	area km^2	in Slovakia (in %)
Nitrianska	5519	100
Trenčianska	4456	100
Šarišská	3652	100
Tekovská	2724	100
Zvolenská	2730	100
Liptovská	2247	100
Turčianska	1123	100
Bratislavská	4370	98
Spišská	3668	94
Oravská	3323	86
Hontianska	2633	82
Zemplínska	6269	72
Abovsko-Turnianská	3323	49
Komárňanska	2843	48
Ostrihomská	1076	48
Novohradská	4133	42
Užská	3230	32
Mošonská	2013	4
Rábska	1527	4

Source: Compiled by the author

2.2 The Impact of Slovakia's Administrative Division on Regional Identity

Changes in territorial division throughout Slovakia's history have led to a layering of regional identity. A typical example is the superimposition of a regional identity based on the administrative division into counties "stolice" or "župy" over the original regional identity based on the region "kraje" system. This is also interesting from a historical perspective, as the territorial division into counties and districts (known as "župy" from 1849 onward) lasted from the Middle Ages until the First Czechoslovak Republic. Meanwhile, the administrative division into the so-called "major regions" (Western Slovakia, Central Slovakia, and Eastern Slovakia) lasted from 1960 to 1996. This is most evident in eastern Slovakia, where the majority of the population identifies as "Easterners" and only a smaller portion as people from Šariš, Spiš, Zemplín, Abov, or Gemer. In Central Slovakia, the Central Slovak identity is also strong, but compared to Eastern Slovakia, older regional identities such as "Oravci" and "Liptáci" are more prominent there. In the border regions, where a significant portion lay outside the territory of Slovakia (for example, the Esztergom, Abov, and Novohrad regions), regional identity based on counties is the weakest.

A distinctive feature of some instances of regional identity in Slovakia is that it has developed independently of territorial-administrative divisions. For example, regional identities have emerged based on geomorphological divisions, such as the Tatranci, Horehronci, and Záhoráci. This type of identity is most pronounced among the Záhoráci, which is also linked to distinct linguistic and cultural attributes related to the Moravian region of Slovácko. The identities of the Gorals, Mantáks, and Sotáks are also characterized by linguistic and cultural attributes. A specific regional identity is the division into Dolniaci and Horniaci, based on significant differences in elevation.

Conclusion

When it comes to the formation of regional identity, the length of time a region has existed is the most important factor, as evidenced by the tendency to identify with the former county or district administrative divisions. In border regions, where a significant portion lay outside the territory of Slovakia, regional identity based on these districts is significantly weaker. The second factor appears to be the size of the territory, as the so-called "major regions" (1960–1996) are still used in regional identity even thirty years after their dissolution. This factor is reinforced by the differences between the dialects of Central and Eastern Slovakia.

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Primary Paper Section: A

Secondary Paper Section: DE, AB

DETERMINANTS OF INDUSTRY 4.0 DEVELOPMENT IN PERIPHERAL AREAS - A QUALITATIVE ANALYSIS FROM THE PERSPECTIVE OF ENTERPRISES, NON-GOVERNMENTAL ORGANIZATIONS, AND LOCAL GOVERNMENTS

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Ministry of Science and Higher Education Republic of Poland, *Barriers and determinants of Industry 4.0 development in selected districts of south-eastern Poland*, grant id: NdS-II/SP/0347/2024/01

Abstract: Industry 4.0, largely equated with digital transformation, is a term referring to the Fourth Industrial Revolution. It has been underway for many years, as the concept was first formulated in Germany as early as 2011. The fourth wave of the industrial revolution refers to the growing digitization and automation of the manufacturing environment. These changes do not affect only the business sector but also impact the functioning of public administration and nongovernmental organizations. The topic of Industry 4.0 has received widespread attention in the literature on the subject. However, a weakness of previous studies is their failure to address the specific conditions of peripheral areas, which lag behind central areas in socio-economic terms. This publication presents the results of a qualitative study conducted using standardized interviews in selected counties of southeastern Poland. As part of the empirical research, 65 interviews were conducted in four counties of the Podkarpackie Voivodeship: Brzozów, Sanok, Lesko, and Bieszczady. The respondents represented three main types of entities: businesses, local government units (LGUs), and the nongovernmental sector (NGOs), which ensured the triangulation of market, administrative, and civic perspectives. The main objective of the study was to identify the barriers and determinants of Industry 4.0 development in peripheral areas. The empirical study indicated that, in the respondents' opinion, the factors hindering the development of Industry 4.0 were predominantly resource-related barriers (financial, human resources, and skills) as well as resistance to change and poor infrastructure. In contrast, the determinants of digital transformation include: digital infrastructure (high-speed internet connections), cooperation and the role of local government, competencies, and financial resources. Among the respondents, the level of knowledge regarding the importance of digital transformation is high but varies. This article presents the most characteristic and valuable statements from the respondents in their full, original form.

Keywords: Poland, Industry 4.0, determinants and barriers, peripheral regions, businesses, local government entities, nongovernmental organizations, qualitative analysis

1 Introduction

Innovation processes in the economy have long been at the very center of interest in economics and management sciences. There are many publications in the academic literature addressing interorganizational collaboration and innovation, including business innovation (see, e.g., Pietruszka-Ortyl 2019; Aluchna et al. 2013; Bratnicka 2014; Wallis 2016). This stems from the fact that innovation and various dimensions of cooperation between organizations are viewed as determinants of corporate efficiency and as a driving force behind the economic and social development of specific regions. Today, a particularly notable manifestation of these processes is the Industry 4.0 concept being implemented in the global economy, which is viewed in many countries as a phenomenon capable of significantly altering the economic landscape at the local, regional, and global levels.

Groundbreaking technological changes have always transformed the manner and structure of production processes and are referred to in the literature as industrial revolutions (see more, e.g., Chalvantharan 2023; Eason et al. 1955; Moloi, Marwala 2020). The First Industrial Revolution began in the 18th century and was associated with the invention of the steam engine (Lu 2017, pp. 1–10) - an economy based on agriculture and artisanal production was replaced by mechanized production utilizing water and steam power. The Second Industrial Revolution, which took place at the turn of the 19th and 20th centuries, was linked to the development of electricity, which enabled mass production and increased the manufacturing efficiency of enterprises; during this period, many management processes designed to boost productivity also emerged, including through the division of labor (Ślusarczyk 2019, pp. 5-6). Both of these revolutions led to increased prosperity among workers and progressive urbanization. The Third Industrial Revolution, which began in the late 1960s, resulted from advances in computers and electronics, which allowed for even more extensive automation and optimization of production processes based on programmable logic control systems, leading to greater efficiency and improved quality (Müller et al. 2018, pp. 2-17).

The next stage of change is the Fourth Industrial Revolution, referred to as Industry 4.0. This concept was formulated in Germany in 2011 as an attempt by the German government to address the negative effects of the economic crisis - the term Industry 4.0 first appeared in November 2011 in connection with a government initiative regarding a high-tech strategy for 2020 (Ślusarczyk 2019, p. 4). Currently, this term refers to the digital transformation of the manufacturing process. There are many definitions of this concept in the literature; one of them, by H. Lasi, states that "Industry 4.0 describes the increasing digitization and automation of the manufacturing environment, as well as the creation of digital value chains to enable communication between products, the environment, and business partners" (Lasi et al. 2014, pp. 239-242). This paradigm thus encompasses digital manufacturing, networked communication, computer technologies, and automation, as well as many other areas of business activity (see also, e.g., Kiełtyka, Charciarek 2019). At the core of the Industry 4.0 concept lies the implementation of digital technologies and the automation of manufacturing processes; the technologies used within this framework include, among others: the Internet of Things (IoT), Big Data, Artificial Intelligence, Robotic Process Automation, Cloud Computing, Virtual Reality, and Additive Manufacturing (see more: Kaczmar-Kolny, Pośpiech 2023; Gajdzik, Grabowska 2018; Różanowski 2007; Szajna et al. 2018).

However, before the concept of Industry 4.0 became firmly established in the literature on the subject, many authors (see, e.g., Moczydłowska 2023; Walicka, Czemiel-Grzybowska 2023; Rządkowski, Sidor-Rządkowska 2024; Januszewska, Fetela 2024) began to formulate the principles of Industry 5.0 - an evolution of Industry 4.0 that emphasizes the design of innovative solutions and sustainable, crisis-resilient, people-centered development. This raises the question of whether the academic discussion regarding the Industry 4.0 concept in the context of economic development and technological change is still relevant, given that the Industry 5.0 concept is already being developed. In the authors' view, it remains relevant, especially with regard to peripheral areas characterized by a lower level of socioeconomic development, where "peripherality" is understood here as a state of lag relative to more developed regions (see more: Idczak 2013; Demianiuk, Szymańska 2016; Wilkin 2003; Feser, Malizia 1999). The Industry 4.0 concept not only influences the development of the industrial sector but also extends to the public and nongovernmental sectors. Consequently, it is particularly important to identify the barriers and determinants of digital transformation, especially in areas characterized by a lower level of socioeconomic development than central regions.

2 Materials and Methods

In order to identify barriers and determinants of digital transformation within the framework of Industry 4.0 in peripheral areas, standardized interviews were conducted in 2026 in selected counties of southeastern Poland. The research was funded by the Ministry of Science and Higher Education under the Science for Society II program (grant no. NdS-II/SP/0347/2024/01). As part of the empirical research, 65 interviews were conducted in four counties of the Podkarpackie

Voivodeship: Brzozów, Sanok, Lesko, and Bieszczady. Each interview was conducted using a standardized questionnaire consisting of eight demographic questions and ten open-ended substantive questions. The respondents represented three main types of entities - local government units (LGUs), nongovernmental organizations (NGOs), and businesses—which ensured the triangulation of administrative, civic, and market perspectives. The analysis of respondents' statements was conducted using qualitative content analysis, supplemented with quantitative elements. During the thematic coding process, at least eight semantic categories were identified for each question. Since respondents often addressed multiple issues simultaneously, a multiple-coding procedure was used, allowing a single response to be assigned to several categories. The resulting categories were then correlated with the respondents' sociodemographic characteristics, treating the type of entity as the main variable and gender, age, years of service, education, job title, county, and type of municipality as supplementary dimensions. The main objective of the research was to identify, in the respondents' opinion, the primary barriers and determinants of the digital transformation of businesses, local governments, and nongovernmental organizations in peripheral areas. This article presents the most characteristic and valuable statements made by the respondents in their full, original wording.

3 Results of the study

A total of 65 respondents participated in the study, which took the form of standardized interviews. Understanding the structure of the sample was a key factor in conducting in-depth qualitative analyses (see Tab. 1).

Tab. 1: Sample structure by selected characteristics (type of entity, respondent's age, position held, county)

TYPE OF ORGANIZATION			***RESPONDENT'S AGE***		
Category	**Percentage (%)**	**Number (n)**	**Category**	**Percentage (%)**	**Number (n)**
Companies	49.2%	32	Companies	49.2%	32
NGOs	30.8%	20	NGO	30.8%	20
Local government units	20.0%	13	JST	20.0%	13
Total	**100.0%**	**65**	**Total**	**100.0%**	**65**
COUNTY SEAT					
Category	**Percentage (%)**	**Number (n)**			
Sanok	40.0%	26			
Brzozów	30.8%	20			
Leski	21.5%	14			
Bieszczady	7.7%	5			
Total	**100.0%**	**65**			
POSITION HELD					
Category	**Percentage (%)**	**Number (n)**			
Management / CEO	41.5%	27			
Specialist / expert	38.5%	25			
Administrative staff	13.8%	9			
Other	6.2%	4			
Total	**100.0%**	**65**			

Source: Own study

The sample of 65 respondents consisted of relatively older, professionally experienced individuals with a high level of education and a clearly decision-making professional profile. Men predominated in the sample - 60.0% (39 people) - while women accounted for 40.0% (26 people). A ratio of approximately 3:2 in favor of men is typical for studies involving executives and company representatives in technical and economic fields. However, the presence of women, accounting for two-fifths of the sample, ensures a significant diversity of perspectives. The largest group consisted of respondents aged 40-49 (38.5%; 25 people), followed by those aged 30-39 (26.2%; 17) and 50-59 (21.5%; 14). The youngest group (up to age 29) accounted for 6.2% (4 people), while the oldest (60 years and older) accounted for 7.7% (5 people). In total, the 30-59 age group comprised 86.2% of the respondents, indicating a strong concentration of the sample among individuals with established professional standing and real influence over organizational decisions. The respondents were characterized by a high level of education; the vast majority held a college degree-78.5% (51 people)-while 21.5% (14 people) had a high school diploma, no respondents in the sample had a primary, lower secondary, or basic vocational education. The respondents had significant professional experience. The largest group consisted of those with over 20 years of experience (44.6%; 29 people). 20.0% (13) reported 11-15 years of experience, and 18.5% (12) reported 16-20 years. Fewer respondents had shorter work experience: 6-10 years (12.3%; 8) and up to 5 years (4.6%; 3). In total, respondents with more than 16 years of work experience accounted for 63.1% of the sample, which may indicate the sample's maturity and a longer comparative perspective in assessing technological changes. In terms of job roles, the sample was dominated by executives/CEOs (41.5%; 27 people) and specialists/experts (38.5%; 25). Administrative staff accounted for 13.8% (9), and the "Other" category accounted for 6.2% (4 people). The combined share of decision-makers and experts was 80.0%, indicating that the survey primarily included individuals with high levels of subject-matter expertise and a real influence on the direction of their organizations' development. The largest number of respondents represented entities from the Sanok County (40.0%; 26 people) and the Brzozów County (30.8%; 20). The Lesko County was represented by 21.5% (14), while the smallest group came from the Bieszczady County (7.7%; 5). The entities' headquarters were most often located in urban municipalities (44.6%; 29), less frequently in rural municipalities (29.2%; 19), and in urban¬rural municipalities (26.2%; 17). Although urban locations predominated, the distribution is relatively balanced - entities from rural or urban-rural areas together accounted for 55.4% of the sample, which allows for a comparative analysis of the conditions of transformation in diverse spatial contexts. Businesses were the most numerous (49.2%; 32 entities), followed by nongovernmental organizations (30.8%; 20) and local government units (20.0%; 13). Nearly half of the sample came from the business sector, which aligns with the study's economic focus; the simultaneous inclusion of NGOs and local government units ensures a triangulation of perspectives - market, civic, and administrative.

An analysis of the structure of the respondent sample, based on the dominant values for each of the characteristics studied, made it possible to outline a synthetic profile of the most typical study participant. This profile is a statistical generalization and does not refer to any specific individual.

Tab. 2: Modal profile of a survey respondent

Characteristic	**Dominant value**	**Percentage**
Gender	Male	60.0%
Characteristic	**Dominant value**	**Percentage**
Age	40-49 years	38.5%
Education	college	78.5%

Years of work experience	Over 20 years	44.6%
Position held	executive / CEO	41.5%
Entity's headquarters	Sanok County	40.0%
Type of municipality	urban municipality	44.6%
Entity type	enterprise	49.2%

Source: Own study

Statistically, the typical survey participant is a man aged 40-49, with a college degree, over 20 years of work experience, and holding a managerial position at a company headquartered in an urban municipality in Sanok County. This profile confirms that the empirical data collected comes predominantly from experienced, well-educated individuals in decision-making positions - that is, respondents with high credibility in assessing the conditions for the development of Industry 4.0.

One aspect of the study was to gather opinions on the barriers and risks associated with digital transformation under the "Industry 4.0" concept in the Brzozów, Sanok, Lesko, and Bieszczady counties, and to determine whether local barriers differ from those at the national level.

According to the respondents, the most serious barrier turned out to be financial constraints, costs, and a lack of capital (64.6% of respondents) - cited by nearly two-thirds of respondents and predominant across all three sectors. The next most frequently cited barriers were: a shortage of qualified personnel (40.0%), low digital literacy and awareness (36.9%), resistance to change and caution regarding investment (30.8%), and poor digital infrastructure (29.2%). These barriers are therefore primarily resource-related - financial, human resources, competency, and infrastructure - rather than technological in the narrow sense.

Tab. 3: Local barriers by type of entity (% of responses within the sector; multiple coding)

Local barrier	**Local Government Units (n=13)**	**NGOs (n=20)**	**Enterprises (n=32)**
Financial constraints and	54%	70%	66%
Shortage of qualified staff	38%	35%	44%
Low digital skills / awareness	46%	55%	22%
Resistance to change / caution	31%	15%	41%
Poor digital infrastructure	38%	30%	25%
Local barrier	**Local Government Units (n=13)**	**NGOs (n=20)**	**Enterprises (n=32)**
Lack of support, guidance, and supplier	8%	30%	19%
Small scale of operations (SMEs)	15%	15%	25%

Source: Own study

The following statements provide the most insightful analysis of barriers in the business sector.

In the local environment, one of the main barriers is the limited financial resources of small and medium-sized enterprises that operate as subcontractors in the automotive industry and are cautious about making large technological investments. There is also a noticeable lack of easy access to specialized consulting firms and Industry 4.0 system integrators in the immediate vicinity, which prolongs and complicates the implementation process. Compared to the national average, barriers related to the region's peripheral location and the lower visibility of local companies in the eyes of major technology partners are felt more acutely.

Respondent ID 15 (male, 40-49 years old, specialist/expert, company, Sanok County)

The most significant local barriers are: a shortage of specialists, limited access to investment financing, a lower level of digitization among SMEs, and limited collaboration between academia and business. Compared to the national level, these barriers are more pronounced, particularly in the areas of human capital and infrastructure.

Respondent ID 56 (female, ages 40-49, specialist/expert, company, Brzozów County)

Although the financial barrier is a common factor, its context varies by sector: in NGOs (70%), it is linked to unstable project funding; in enterprises (66%), it is linked to SMEs' investment caution. Businesses were clearly distinguished by resistance to change and investment caution (41% versus 15% in NGOs); NGOs - by low digital literacy among their audiences and their own staff (55%) and a lack of support and guidance (30%); and local government units - by infrastructure and competency issues.

During the interviews, respondents were also asked whether local barriers differed from those at the national level. A comparison with the national level yielded an almost unanimous conclusion. More than half of the respondents did not directly address the comparison; however, among the 29 who did, as many as 28 (96.6%) considered local barriers to be different from or more significant than national ones; only one person did not perceive a difference. The prevailing interpretation is that the region faces the same types of barriers as the rest of the country but has fewer resources to compensate for them-its peripheral location acts as an "amplifier." A local government representative captured this most comprehensively in systemic terms:

barriers related to competence, infrastructure, and finance; organizational, institutional, cultural, and social barriers; legal and regulatory barriers; information and communication barriers; and demographic barriers. Yes-they are different, though some of them are shared. The differences mainly concern the scale, intensity, and nature of the problems

Respondent ID 14 (female, 40-49 years old, specialist/expert, local government entity, Leski County)

Based on the information presented, it can be concluded that the barriers to the development of Industry 4.0 in the counties studied are primarily resource-related - financial, human resources, skills, and infrastructure - rather than strictly technological. According to nearly all respondents who commented on the comparison, these barriers do not differ in nature from nationwide barriers, but rather in intensity: the region's peripheral location makes them more acutely felt and more difficult to compensate for.

Another objective of the study was to identify the factors determining the technological and organizational transformation of enterprises in the four counties and to determine whether these determinants differ from those at the national level.

Respondents view transformation primarily in pragmatic terms - as a tool for streamlining day-to-day operations. However, the direction of transformation (internal/external) is strongly sector-specific: enterprises focus their transformation almost exclusively inward (optimization, monitoring), local governments - outward, toward serving residents (e-services), and non-governmental organizations - toward analytics,

communication, and competencies. Cybersecurity as an application appeared exclusively in businesses (13%) - in no NGOs or local government units - which signals a gap in awareness of digital risks in the public and social sectors. The picture of intra-organizational integration of the production cycle may be described by a specialist from the business sector, while a statement from a respondent at a non-governmental organization may indicate that this is a way to overcome geographical barriers.

Technological and organizational transformation allows for better integration of a designer's work with production, quality control, and logistics (...). The implementation of integrated PLM and MES systems enables tracking of a part's entire lifecycle-from concept, through prototyping, to mass production and service. Additionally, the use of numerical simulations and digital twins helps reduce the number of costly physical tests and shorten the time it takes to bring new solutions to market.

Respondent ID 15 (male, 40-49 years old, specialist/expert, company, Sanok County)

In our case, solutions such as electronic health records, patient management systems, telecounseling, and remote specialist consultations are key. In Bieszczady County, distance is a real problem, so teleservices can improve access to psychological and therapeutic support. From an organizational standpoint, this also means better team work planning and analysis of data regarding residents' needs.

Respondent ID 20 (female, ages 40-49, executive/president, nongovernmental organization, Bieszczady County)

The question about the beneficial aspects of the transformation and the reasons behind them allowed us to distinguish between what respondents want to implement and what they expect from these implementations. The research indicated that there are sector-specific differences in the types of expected benefits. Businesses "judge" the transformation based on quality and costs; local governments - on the efficiency of services provided to residents (e-services); and NGOs - on accessibility and reach. The most striking contrast concerns the benefit of "greater reach and accessibility": 60% of NGOs cited it, while - significantly - not a single business representative did. System integration remains the common denominator across all sectors. The following statement by a respondent illustrates this point.

The most beneficial tools are: digital communication and social media tools, systems for managing events and participant databases, analysis of audience data, and automation of administrative processes. The primary benefits are improved communication, a faster flow of information, and the ability to better tailor offerings to the needs of the local community.

Respondent ID 23 (female, 60 years or older, administrative staff member, nongovernmental organization, Leski County)

According to the respondents, the most important factor determining digital transformation is digital and technical infrastructure - above all, access to high-speed Internet, the lack of which is perceived as a fundamental constraint. Most factors were described in terms of deficits. A clear pattern is the so-called "local government gap": the factor of cooperation and networks, strongly emphasized by businesses (41%) and nongovernmental organizations (50%), was almost completely overlooked by local governments (8%). The entities that naturally serve as coordinators of local networks are the least likely to recognize this function as a determinant of the digital transformation process. Sectoral profiles are distinct: local governments emphasize infrastructure and competencies as key factors; businesses highlight workforce availability and the structure of the economy; and NGOs focus on collaboration and social attitudes. The following statement offers the most insightful analysis of local conditions, linking the shortage of skilled personnel to the region's peripheral location.

In our local community, the availability of qualified technicians and engineers is a key factor, which is not a given in peripheral counties such as Sanok County due to the outflow of young people to larger cities. Transportation infrastructure and stable cooperation between automotive companies and local schools and universities are also important (...). Compared to the nationwide context, the limitations of market scale and the smaller number of specialized entities supporting implementation are more pronounced here.

Respondent ID 15 (male, 40-49 years old, specialist/expert, company, Sanok County)

In the respondents' view, the region faces the same transformation challenges as the rest of the country, but has poorer infrastructure, fewer specialists, and limited access to capital and research and development centers. The contrast between the local and national levels is best illustrated by the following statements from respondents.

Local: access to high-speed Internet, human resources (whether there are specialists nearby), local service and training companies, and the level of cooperation between local government and businesses. Differences: At the national level, there are support programs and larger R&D centers; locally, access to these resources may be limited, so implementations proceed more slowly and require local adaptation.

Respondent ID 16 (male, 50-59 years old, specialist/expert, business, Leski County)

At the local level, access to infrastructure, the level of social activity, and the ability of various entities to collaborate are key. Compared to the national level, social and demographic factors-such as an aging population and the migration of young people-are more significant here.

Respondent ID 63 (female, ages 40-49, specialist/expert, nongovernmental organization, Sanok County)

A synthesis of the statements made by individual respondents leads to the conclusion that the pace and success of transformation in the region are determined primarily by resource- and infrastructure-related factors, with high-speed Internet taking precedence. These determinants are - in the respondents' assessment - identical to national factors but available on a smaller scale; conversely, barriers and peripheral location weaken the determinants of development. An analysis of applications and benefits further reveals strong, sector-specific "value maps" of transformation: production-and-quality-oriented in businesses, service-and-public-sector- oriented in local government, and relationship-and-accessibility-oriented in nongovernmental organizations. An institutional factor of particular importance-and at the same time one of which local governments are least aware - is cooperation and the networks connecting individual entities from the business sector, public administration, and the non-governmental sector.

The study also assessed the level of knowledge among local and regional entrepreneurs, local government representatives, and non-governmental organizations regarding the transformation within the "Industry 4.0" concept, as well as the variation in this knowledge across the surveyed groups.

Respondents' answers in this regard were notably detailed, indicating familiarity with the "Industry 4.0" concept among the surveyed group. The core of respondents' answers in this area consists of two nearly equivalent associations - digitalization and automation/robotization - common to all sectors. More technical elements (data, IoT/integration, optimization) were significantly more common in the business sector, indicating a more

systematic understanding of the concept there. It is also noteworthy that the topic of data was least frequently mentioned in local government, and cybersecurity was entirely absent in that sector. In addition to the content of the associations, the study assessed the depth of understanding of the term "Industry 4.0." Most respondents demonstrated a general but correct understanding; one-fifth demonstrated an in-depth, expert understanding based on specific technologies; and only 12.3% demonstrated a superficial or uncertain understanding. This indicates a high, though varied in terms of depth, prevalence of the Industry 4.0 concept in the region. The depth of understanding is clearly linked to sociodemographic characteristics. The most technical and comprehensive definitions were provided by specialists and executives at industrial companies - it was within this group that expert-level understanding was concentrated. Non-governmental organizations primarily equated Industry 4.0 with digitization, less frequently referring to data or optimization; local governments presented a balanced understanding, but placed the least emphasis on data and cybersecurity. The following statements by respondents serve as examples.

I associate Industry 4.0 with a strong integration of the physical and digital worlds, in which machines, production lines, IT systems, and people are integrated into a single network that exchanges data in real time. This includes the use of advanced CAD/CAE tools, PLM systems, IoT sensors, data analytics, and artificial intelligence, which enable continuous process optimization. In the automotive industry, this means, among other things, the ability to design components using digital twins and a close link between the design office and actual production.
Respondent ID 15 (male, 40-49 years old, specialist/expert, company, Sanok County)

Connecting machines and systems via the Internet (IoT), automation, robotics. Data collection and analysis (reports, charts) for better planning. Smart manufacturing: remotely monitored machines, predictive maintenance. Overall: "a factory that thinks and communicates," meaning more data and less manual labor.
Respondent ID 16 (male, 50-59 years old, specialist/expert, company, Lesko County)

A notable trend was the deliberate expansion of the concept beyond the industrial sector. Representatives of the social sector and local government adapted the concept to their own contexts - culture, therapy, healthcare, and rural development - treating it as a broad civilizational process rather than solely a manufacturing phenomenon. This demonstrates a functional understanding rooted in the organization's mission.

I understand Industry 4.0 as a stage in economic development based on automation, robotization, the integration of IT systems, and the use of real-time data. It also involves work at the human-machine interface, the Internet of Things, data analysis, and intelligent management support systems. For me, it is not just industry in the manufacturing sense, but more broadly-a transformation of the entire service delivery model.
Respondent ID 24 (female, 40-49 years old, executive/CEO, nongovernmental organization, Leski County)

The level of knowledge about the "Industry 4.0" concept is high among the surveyed population (correct or expert-level understanding), but varies in depth and scope. There is a clear distinction between groups: the deepest, most technical understanding is found among specialists and management staff at industrial companies, as well as among individuals with higher education; the social sector and local government tend to understand the concept in a broader, functional sense - through the lens of their own mission - and are less likely to delve into its technical core (data, integration, cybersecurity). The high, albeit uneven, level of knowledge serves as a favorable starting point: the barrier to transformation is not a lack of understanding of the concept, but a shortage of resources to implement it.

4 Conclusion

The standardized interviews conducted allowed us to draw several concluding insights and to identify barriers and determinants of the development of the Industry 4.0 concept. The empirical study indicated that the strongest factor differentiating respondents' opinions was the type of entity. Each of the groups surveyed employs a different "map" of transformation: businesses view it from a market- and technology-oriented perspective (optimization, competition, quality, engineering staff, dependence on systems); nongovernmental organizations view it from a social and relational perspective (funding, accessibility, digital exclusion, social competencies, communication), and local governments - in terms of public services (e-services, infrastructure, environmental tasks, cybersecurity of residents' data). This sector-specific logic proved stronger than any single individual characteristic and recurred consistently in all respondents' statements. Empirical research has shown that, in the respondents' opinion, the factors hindering the development of Industry 4.0 were dominated by resource-related barriers - financial, human resources, and competency-related - complemented by resistance to change and poor infrastructure. In the assessment of nearly all respondents, these barriers differ from those at the national level not in type but in intensity: their peripheral location exacerbates them. In contrast, the determinants of digital transformation include: digital infrastructure (with a focus on high-speed Internet), cooperation and the role of local government, competencies, and financial resources. Nearly 70% of all respondents believed that the local conditions determining digital transformation in peripheral areas are different (weaker) than national conditions. The level of knowledge about the Industry 4.0 concept and digital transformation is high; and nearly all respondents understood it correctly and with expert-level knowledge; however, this knowledge varies - the most advanced level of understanding is found among industrial enterprises and individuals with higher education, while the social sector and local government tend to understand the concept of Industry 4.0 in a broad and functional sense, rather than from a technical perspective. The patterns presented in the text are descriptive in nature and result from a qualitative study with a limited, unevenly distributed sample. The most significant limitation of the empirical study is the small size of the groups from individual sectors, which necessitates treating the analysis results with a certain degree of caution. However, despite these limitations, the collected data provide a reliable, cross-sectional assessment of barriers, determinants, and the state of knowledge in four counties of southeastern Poland. The identified patterns - with the type of entity as the primary differentiating variable, peripherality as a common denominator, and the disconnect between awareness and resources and institutions - provide an accurate picture of the conditions for the development of Industry 4.0 in a region defined as peripheral, and also indicate the necessary directions for intervention by businesses, local government, and the non-governmental sector.

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Primary Paper Section: A

Secondary Paper Section: AH

RADIATION ACCIDENT IN THE EMERGENCY PLANNING ZONE OF THE TEMELIN NUCLEAR POWER PLANT AS A RESULT OF A TERRORIST ATTACK

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Abstract: This paper examines the protection of the population within the emergency planning zone of the Temelin Nuclear Power Plant (Temelin NPP), during a model radiological emergency caused by a terrorist attack. Attention is given to the importance of nuclear power for the energy security of the Czech Republic, security treats to critical infrastructure, and the emergency preparedness system. The paper analyses basic protective measures in the event of a radiological accident, particularly public warning, sheltering, evacuation, decontamination, and iodine prophylaxis. The paper includes a model scenario demonstrating the activities of the Integrated Rescue System (IRS) components and the organization of the emergency response under radiological accident conditions. The results confirm the importance of coordinated crisis management, regular preparation of emergency plans, and public education to minimize the consequences of emergency events.

Keywords: civil protection, critical infrastructure, emergency preparedness, radiation accident, Temelin Nuclear Power Plant, terrorism

1. Introduction

Nuclear energy represents a significant, stable, and low-emission source of electricity and, at the same time, a key component of the critical infrastructure in the Czech Republic. In the context of increasing demands for energy security, power-grid stability and the decarbonisation of the energy sector, the importance of nuclear power plants is growing not only in terms of electricity production but also from the broader perspective of national security. The current security environment, however, also introduces new asymmetric threats, including terrorism, cyberattacks, and hybrid forms of disruption targeting critical infrastructure.

Nuclear power plants are facilities of high strategic importance, and any disruption to them could have serious security, economic, environmental and psychological consequences. For this reason, it is essential to focus not only on the technical and operational safety of nuclear facilities but also on emergency preparedness systems and the protection of the population in emergency planning zones.

The Temelin NPP is a key component of the Czech energy infrastructure and which contributes to maintaining the stability of the national power grid. In the event of a radiological emergency, it is essential to ensure rapid coordination of the emergency response, effective public communication, and the implementation of protective measures, particularly sheltering, evacuation, decontamination, and the monitoring of the radiological situation.

This paper examines population protection within the emergency planning zone of the Temelin NPP during a model radiological accident caused by a terrorist attack. The objective of the paper is to analyse the principles of emergency preparedness, describe the fundamental protective measures, and, through a model scenario, demonstrate the practical application of radiation-protection principles, the organization of evacuation, and the activities of the Integrated Rescue System (IRS).

1.1 The Temelin NPP as a strategic element of the energy infrastructure

The Temelin NPP represents one of the most significant elements of electric power system in the Czech Republic and, at the same time, an important component of national energy security. It is located in the South Bohemian Region, approximately 25 km north of České Budějovice, near the town of Týn nad Vltavou. The power plant site was selected, among other factors, with regard to suitable geographical, technical, and safety conditions. For the purpose of cooling the power plant, the Hněvkovice Reservoir (1, 25) was constructed on the Vltava River.

Construction of the Temelin NPP began in the 1980s as part of the development of Czechoslovak nuclear power. The original design envisaged four units, but following the social and economic changes after 1989, it was decided to complete only two units (12, 21). The first unit was commissioned in 2000, followed by the second unit in 2002 (24, 25).

The plant is equipped with two VVER 1000/V320 pressurized water reactors. Each unit has a capacity of approximately 1,125 MWe, and the total installed capacity of the plant is approximately 2,250 MWe. Annual electricity production is around 15 TWh, which represents a significant share of total electricity production in the Czech Republic (17, 24, 25).

From a technological standpoint, the plant's operation is based on the use of VVER-type energetic reactors, i.e., Water-Water Energetic Reactors (VVER), a type of pressurized water reactor. Their operation is based on the use of water as both a neutron moderator and a coolant in the primary circuit. Although both Czech nuclear power plants use a similar technological design, they differ in output, layout, and certain technical parameters (6, 25).

From an energy policy perspective, the Temelin NPP represents a strategic low-emission source of electricity. Nuclear power is currently regarded in the European Union as a significant and stable source that can contribute to the decarbonisation of the energy sector, the reduction of greenhouse gas emissions, and the strengthening of energy security in member states (13). According to data from the World Nuclear Association, approximately 440 nuclear reactors were in operation worldwide in 2024, and dozens more were under construction (28).

The Czech Republic has long envisaged further development of nuclear power, particularly through the construction of new nuclear units at the Dukovany and Temelin sites. At the same time, the potential deployment of small modular reactors is also being discussed (26, 28). From the perspective of critical infrastructure protection, Temelin is therefore not merely a power generation facility but a strategic asset of fundamental importance for the stability of electric power system in the Czech Republic.

Given the importance of the Temelin Nuclear Power Plant, there is a need for systematic protection against security threats. In addition to technical and operational safety, attention must also be paid to physical protection, cybersecurity, emergency preparedness, and emergency planning (1, 21).

1.2 Terrorist attacks on the nuclear power plants as a security treat

Terrorism represents a long-term and serious security threat in the modern world. It does not consist merely of isolated acts of violence, but rather constitutes a complex security phenomenon associated with political, ideological, religious, or social motives. Bonanate states that terrorism is an urgent and evident reality that cannot be eliminated by repressive measures alone, as its essence is linked to the motivation of individuals or groups willing to sacrifice their own lives and the lives of others in the name of an ideal or goal (4).

According to Waisová, terrorism can be characterized as premeditated and politically motivated violence directed against civilian or military targets, individuals, or groups. Its purpose is to intimidate, inflict harm, or kill people in order to achieve

political or ideological objectives, with the chosen targets often having symbolic significance (27). Pillar, meanwhile, emphasizes that terrorism should be understood primarily as a specific method of violence rather than merely as a characteristic of certain groups or ideologies (22).

In the field of energy security, terrorist threats are primarily associated with attacks on critical infrastructure. Ivančík and Kelemen note that significant asymmetric security threats include attacks on oil refineries, product pipelines, transmission systems, power plants, nuclear facilities, and the information and communication systems of energy networks (18). From this perspective, energy infrastructure represents an attractive target, as its disruption can have widespread economic, social, and security impacts.

Nuclear power plants represent a specific category of critical infrastructure. They are a key source of electricity and, at the same time, facilities with stringent requirements for security, physical protection, and crisis management. Although nuclear power plants are considered "hard targets" with a high level of protection against unauthorized intrusion or attack, the risk of a targeted attack cannot be entirely ruled out. Terrorist organizations have demonstrated in the past both the intent and the capability to target critical infrastructure assets (14).

From the perspective of security studies, the objectives of terrorist attacks can vary. Bennett notes that the primary aims of terrorist organizations include causing loss of life, damaging or destroying critical infrastructure, disrupting the economy, undermining public confidence in state institutions, or generating a long-term psychological impact on society (3). An attack on a nuclear power plant could thus have not only immediate security consequences but also significant psychological, economic, and political impacts.

The U.S. Department of Homeland Security defines terrorism as an activity dangerous to human life or having the potential to destroy critical infrastructure, with the aim of intimidating the population, influencing government policy through coercion, or shaping government action through destructive acts (16). This definition emphasizes that critical infrastructure, including nuclear facilities, may be a target of attacks aimed at destabilizing society and the state.

From the perspective of nuclear power plant security, it is therefore essential to focus on multi-layered physical protection, technical security measures, access control, detection and monitoring systems, armed protection, cybersecurity, and emergency preparedness. Modern security systems at nuclear power plants are based on a combination of preventive, detection, delay, and response measures.

In the current security environment, cyberattacks against energy infrastructure also pose a significant threat. The digitization and automation of energy facility operations increase operational efficiency while simultaneously creating new vulnerabilities associated with the potential disruption of control and communication systems. The combination of physical and cyber threats can trigger serious cascading effects in critical infrastructure.

The importance of these facilities lies not only in electricity generation, but also in their stabilizing role within the electric power system and in the state's ability to ensure the continuity of essential services.

1.3 Emergency planning zone and protective measures in the event of a radiological emergency

Given the safety significance of nuclear power plants and the potential threats they face, an emergency preparedness system has been established. Nuclear power plants are facilities for which it is necessary to plan not only the prevention of emergency events, but also protective measures in the event that a radiological emergency occurs. The emergency preparedness system in the Czech Republic is based primarily on the Atomic Energy Act, the Act on the Integrated Rescue System, the Crisis Management Act, and related implementing regulations (9, 10, 11).

Emergency preparedness represents a state in which conditions are established within a given territory or organization to manage emergency events through planning, organizational measures, the activities of the Integrated Rescue System, and the population protection system (10). The Integrated Rescue System is a coordinated system of units designed to carry out rescue and recovery operations during emergencies, crisis situations, and accidents (10).

Population protection encompasses a set of organizational, technical, and material measures aimed at protecting people from the effects of hazardous chemical, biological, and radioactive substances. It includes, in particular, means of individual protection for the respiratory tract, eyes, and skin, as well as sheltering, evacuation, and decontamination measures (19).

A radiological emergency is a situation in which established radiation exposure limits are exceeded or may be exceeded and which requires the implementation of measures to protect the population and the environment (9). Depending on their nature and scope, radiological emergencies may be classified as local incidents, incidents involving a limited release of radioactive substances, and radiological accidents that require the activation of protective measures in accordance with the external emergency plan (20).

In the event of a radiological accident, an emergency planning zone is established in the vicinity of nuclear facilities. The Atomic Energy Act defines the emergency planning zone as an area for which measures to protect the population must be prepared in the event of a radiological accident (9). The extent of this zone is determined on the basis of the characteristics of the facility, the quantity of radionuclides, and possible accident scenarios. Further details are specified in Decree No. 359/2016 Coll., which also regulates the requirements for emergency planning and the preparation of protective measures (7).

Basic protective measures within the emergency planning zone include public warning, sheltering, evacuation, iodine prophylaxis, regulation of the movement of persons, and decontamination. Protective measures are a set of procedures intended to protect the population during emergency events (8). Evacuation is an organized relocation of the population from a threatened area to a safe area in accordance with pre-prepared population protection plans (8).

An important element of population protection is sheltering, the purpose of which is to reduce the risk of inhalation or external contamination by radioactive substances. In such cases, the population is advised to close windows and doors, turn off ventilation systems, and limit outdoor activities. In the event of a risk of radioactive iodine release, iodine prophylaxis may be ordered.

An integral part of radiation protection is the monitoring of the radiological situation, in particular the monitoring of dose rate. Dose rate expresses the change in absorbed dose of ionizing radiation per unit of time and is used to assess the intensity of the radiation field (23). In practical radiation protection, units such as μSv/h or mSv/h are commonly used. The magnitude of the dose rate depends on radiation intensity, its energy, and the absorption properties of the surrounding environment (2).

Regional and external emergency plans play a significant role in the emergency preparedness system. The external emergency plan defines specific measures for the protection of the population in the vicinity of a nuclear facility and includes procedures for public warning, evacuation, decontamination, distribution of iodine prophylaxis, and regulation of the movement of people (5). In the case of the Temelin NPP, the emergency preparedness system primarily includes the

Emergency Plan of the South Bohemian Region and the external emergency plan of the plant (15).

Several entities are involved in the preparation and implementation of emergency measures. The operator of the nuclear facility prepares the internal emergency plan and ensures personnel preparedness. Public administration authorities are responsible for external emergency planning and population protection. The State Office for Nuclear Safety exercises supervision over emergency preparedness, and the components of the Integrated Rescue System ensure the practical implementation of protective measures, particularly evacuation, decontamination, and medical assistance (9).

An important component of population protection is public preparedness. Residents within the emergency planning zone must be regularly informed about warning methods, rules of conduct in the event of a radiological accident, and the possibilities for using protective measures. Public preparedness is supported through the distribution of informational materials, training activities, and regular exercises organized by the components of the Integrated Rescue System and public administration authorities (8, 11).

From the perspective of state security, the system of emergency preparedness and population protection represents a key instrument for minimizing the consequences of radiological accidents. Effective coordination among the operator of the nuclear facility, public administration authorities, the components of the Integrated Rescue System, and the population is an essential prerequisite for the successful management of an emergency event and for limiting its impacts on society and the environment. The effectiveness of these measures is subsequently verified through model radiological accident scenarios, which make it possible to assess the preparedness of individual crisis management components as well as the population.

2 Methodology

The methodology of this paper is based on the objective of analysing options for the protection of people within the Emergency Planning Zone (EPZ) and applying the principles of radiation protection to a selected model radiological emergency. The methodological approach combines the study of professional literature, legislative documents, emergency plans, and response instructions with subsequent modelling of the radiological situation and evaluation of protective measures.

The following part of the paper is based on the simulation of a model radiological emergency within the EPZ. The model situation is analysed using a scenario-based approach that enables the simulation of the course of a radiological emergency and the assessment of the effectiveness of protective measures. The presented model situation addresses a radiological accident at a nuclear power plant involving the release of radionuclides into the environment. First, the event scenario itself is described, including the location of the incident, the nature of the radiological hazard, the affected persons and equipment, and the anticipated extent of impacts on the surrounding area. Subsequently, the radiological situation is determined, including an assessment of dose rate and the risk of internal or external contamination. For the delineation of individual response zones, limit values specified in emergency plans and response instructions are applied.

The methodology also includes a description of the activities of the responding units, in particular the plant fire brigade, dosimetrists, emergency response units, and other components of the Integrated Rescue System (IRS), where activated. For the described situation, protective measures for both responders and the population are defined, including the use of personal protective equipment, decontamination procedures, and monitoring of the radiological situation.

The final stage of the methodological procedure is the evaluation of the model situation. This includes an assessment of the effectiveness of the adopted measures, their compliance with applicable legislation and radiation protection principles, as well as the identification of potential risks and complications and formulating recommendations for practice. This approach makes it possible to comprehensively assess preparedness for radiological emergencies within the EPZ and the specific aspects of response to an accident at a nuclear facility.

3 Model scenario

The model scenario represents a fictional case of a radiological accident at the Temelin NPP affecting the Emergency Planning Zone (EPZ). The aim is to demonstrate the practical application of radiation protection principles, emergency response procedures, and decontamination measures. Although this is a model case, the individual steps correspond to real organizational and technical procedures used at nuclear power plants in the Czech Republic.

During the morning hours, a terrorist attack occurred on Unit 1 during normal operation. The attack was extensive and resulted in a sudden increase in dose rate within the containment area. Security forces neutralized the attackers, after which the emergency response was initiated. The continuous monitoring system recorded a gradual increase in measured values in the vicinity of the primary circuit technological equipment. Control measurements performed by a dosimetrist confirmed the presence of radioactive aerosols within the containment and their release into the environment. The measured values exceeded established limits; therefore, the event was classified as a radiological accident (emergency event of Level 3). In accordance with standard procedures, the plant emergency staff, the plant fire brigade, the radiation protection unit, and other emergency preparedness components were activated.

Due to an eastern wind, the plume of radioactive aerosols began to move toward Sectors 12, 13, and 14 within the EPZ of the Temelin NPP. These sectors form an area extending from the plant in the direction of the towns of Protivín and Číčenice. Sector 12 covers the area surrounding Číčenice, Sector 13 represents the transitional area between Číčenice and Protivín, and Sector 14 includes the territory in the vicinity of Protivín. All of these sectors comprise a number of smaller municipalities in which identical protective measures were declared. In the affected sectors, mobile monitoring units and field response teams were deployed. In coordination with data from the teledosimetric system (TDS), these units refined and specified the radiological situation in the field.

Elevated dose rate values were measured, naturally decreasing with increasing distance from the source of the release. Within a radius of approximately one kilometer from the plant, the values ranged around 1.5–2.0 mSv/h; at a distance of five kilometres, they decreased to below 100–200 μSv/h; and at a distance of ten kilometres, they fell below 30–50 μSv/h. These values corresponded to a short-term release without a significant contribution of radioactive iodine. The reported values represent model, indicative dose rate levels corresponding to a short-term release of radionuclides of limited extent.

Since the spread of contamination affected Sectors 12, 13, and 14, two evacuation routes designated for this part of the Emergency Planning Zone (EPZ) were selected for evacuation. Evacuation Route No. 3 leads from the vicinity of the power plant through Číčenice toward Vodňany, where Decontamination Site No. 3 is located. This route was used primarily for the evacuation of the population from Sector 12 and part of Sector 13. For residents of Sector 14, Evacuation Route No. 4 was activated, leading through Žďár to Nový Dvůr, where Decontamination Site No. 4 was activated. Both decontamination sites are located outside the contaminated areas in order to ensure easy accessibility from main transport routes and to enable the smooth movement of both people and equipment.

The Police of the Czech Republic ensured traffic control throughout the entire affected area. Access to Sectors 12, 13, and 14 was closed, control checkpoints were established on the main access roads, and measures were taken to prevent unauthorized persons from entering the area. At the same time, the police managed traffic along Evacuation Routes No. 3 and No. 4, where it was necessary to ensure the smooth movement of evacuation vehicles as well as emergency response units. The police also provided security for both decontamination sites and coordinated the arrival of evacuees from individual municipalities.

The transport of the population from the affected sectors is carried out using a combined approach. The majority of residents evacuate using their own vehicles, which enables rapid relocation and reduces the burden on evacuation buses. For individuals without access to private transportation, evacuation buses organized by the municipalities in cooperation with the IRS are provided. Special attention is paid to people with limited mobility. As part of emergency preparedness, the mayors of the affected municipalities maintain records of these residents, and ambulance vehicles or Fire and Rescue Service (FRS) vehicles are deployed for their transport to ensure their timely evacuation. Units of the company's Fire and Rescue Service (FRSp), in cooperation with the South Bohemian Regional Fire and Rescue Service, provided technical support and carried out decontamination processes. Along Evacuation Routes No. 3 and No. 4, they established and operated vehicle decontamination stations, where vehicles leaving the affected sectors were cleaned. At the same time, they participated in the establishment of Decontamination Sites No. 3 and No. 4 for the decontamination of persons and ensured water logistics as well as the handling and disposal of contaminated waste materials. A monitoring team conducted supplementary monitoring of the radiological situation in the immediate vicinity of the power plant and transmitted the measured values to the radiation protection unit. Firefighters also provided fire safety assistance at damaged technological units where there was a risk of fire due to non-standard operating conditions.

When implementing decontamination measures, it is essential to follow to the correct sequence of steps. This procedure includes an initial screening check, possible decontamination of both equipment and personnel, and a subsequent exit check before entering the clean zone.

Immediately after the declaration of the radiological event, protective measures consisting of sheltering the population in buildings, closing windows, and limiting outdoor activities were implemented throughout the affected area of the Emergency Planning Zone (EPZ). The intake of iodine prophylaxis was also ordered, as the released radionuclides could have contained quantities of radioactive iodine; this represented a conservative approach. Subsequently, a controlled evacuation using improvised evacuation means was ordered for Sectors 12 to 14, where dose rate values of 30–50 μSv/h were measured. This measure primarily concerned residents of municipalities located in the immediate vicinity of the release and individuals who were present outdoors at the time of the event. Information was disseminated through warning systems and local public broadcasts. The meteorological situation was continuously evaluated in order to anticipate further dispersion of radionuclides.

Directly within the power plant premises, monitoring portals detected several contaminated individuals among the personnel. These individuals were immediately directed to designated areas, where decontamination of both the people and their protective equipment was carried out. In the case of two workers, surface contamination of the hands and footwear was confirmed and successfully removed. No internal contamination was detected.

Following the stabilization of the situation, sealing of the affected technological equipment was initiated, along with the gradual reduction of radionuclide concentrations in the air using filtration systems. The emergency staff and other emergency response components coordinated subsequent actions, including the assessment of the radiological situation in the affected sectors, monitoring of meteorological conditions, and preparations for potential further interventions.

After the acute phase of the accident had subsided, control sampling of soil, water, and vegetation was carried out in the vicinity of the power plant as well as in the affected municipalities in order to assess the environmental impacts. Finally, the entire event was evaluated in terms of the effectiveness of the measures adopted. The rapid activation of emergency response units, appropriate delineation of zones, timely public information, and effective traffic management prevented the spread of contamination beyond the anticipated sectors. The model scenario thus demonstrates the importance of coordinated emergency preparedness and the correct application of radiation protection principles during emergency events affecting the emergency planning zone.

3.1 Potential complications and failures in the model scenario

Although the model scenario describes an ideal course of response, a real emergency event may be influenced by a number of factors that could slow down or disrupt evacuation operations. The following section summarizes the most likely complications that could occur during the evacuation process.

A frequent complication may be a traffic accident on an evacuation route. Although evacuation routes are selected to ensure sufficient capacity and good traffic flow, a collision involving a private vehicle, a technical failure, or a sudden blockage of the roadway cannot be ruled out. In the case of a minor accident that does not compromise the traffic flow of the route, occupants of the damaged vehicle may be collected by acquaintances or transported by components of the Integrated Rescue System (IRS) to the nearest evacuation point in order to avoid delays in the evacuation process. If the route becomes completely impassable, it is necessary to inform the Police of the Czech Republic or other Integrated Rescue System components. The report may be made by the participant in the accident, if capable, or by any evacuee who observes the incident. The police subsequently designate an alternative route or decide to redirect all traffic to another evacuation route. In the present scenario, if Evacuation Route No. 3 were blocked, evacuation could be redirected to Evacuation Route No. 4. These measures ensure that evacuation can continue even in the event of a sudden blockage of the primary route.

Another complication that may affect the evacuation process is a situation in which a resident refuses to leave their home. A typical example may involve an elderly woman who informs a neighbour in advance that she does not intend to evacuate and will remain at home. The neighbour, during the boarding an evacuation bus, notices that the woman is not among the evacuees and informs the evacuation vehicle coordinator. An attempt at telephone contact follows, which often remains unsuccessful. If firefighters or another Integrated Rescue System component have sufficient capacity and resources, a patrol carries out a personal check and attempts to establish direct contact at the residence. If, however, repeated knocking or banging on the door elicits no response and the situation does not allow further delay of the evacuation, the IRS components continue their operations and the person remains sheltered in place. The name of the person is forwarded to the crisis staff, which classifies them among people requiring subsequent follow-up after the acute phase of the event has subsided. This procedure reflects the need to balance an individual approach to residents with the requirement to ensure the smooth and timely evacuation of the entire sector.

Another specific complication may be the presence of domestic animals. Some residents refuse to evacuate without their pets, which can delay boarding of evacuation buses and disrupt the organization of the entire process. However, evacuation is primarily focused on the protection of people rather than animals; therefore, residents are advised to leave their pets in

enclosed areas within their homes. If residents nevertheless take their pets with them, it is preferable that the animals be placed in a transport crate or carrier bag that allows safe transport without posing a risk to other evacuees. An animal not secured in a crate or carrier may cause disorder, bite or scratch individuals, induce stress among other evacuees, or complicate subsequent decontamination procedures.

An integral part of emergency preparedness for residents within the Emergency Planning Zone in the event of a release of radioactive substances is the requirement to use improvised evacuation protective equipment during evacuation, such as a raincoat, rubber boots, a cap, and a respirator or another means of respiratory protection. These items serve to reduce the risk of surface contamination and to protect other evacuees. If, however, an individual arrives at an assembly point or evacuation bus without such protective equipment, they cannot be included among the evacuees, as they could pose a risk to the safety of others. In such cases, the individual is either directed to individual evacuation, for example using their own vehicle, or provided with substitute protective clothing, such as a disposable protective suit, which is available to the components of the IRS. After being equipped with substitute protective clothing, the individual may continue evacuation together with others. Personnel at the decontamination site are informed in advance that this individual requires a more thorough inspection. This procedure ensures that evacuation proceeds safely and that other people within the evacuation flow are not endangered.

Conclusion

Nuclear power plants represent a significant element of a state's critical infrastructure and, at the same time, a strategic source of electricity whose importance continues to grow under current energy policy conditions. With the increasing importance of nuclear power, the requirements for protecting these facilities against security threats are also rising, particularly with regard to terrorist and cyberattacks. The security of nuclear facilities therefore encompasses not only the technical safety of operation, but also a comprehensive system of emergency preparedness and population protection.

The presented model scenario of a radiological accident at the Temelin NPP confirmed the importance of a coordinated emergency response, rapid activation of the components of the Integrated Rescue System, and effective monitoring of the radiological situation. At the same time, it demonstrated the significance of proper delineation of affected sectors, the organization of evacuation, and timely public information within the emergency planning zone.

The model scenario also highlighted potential complications that may adversely affect the implementation of protective measures, such as traffic restrictions, refusal of evacuation by some residents, or insufficient use of personal protective equipment. These factors confirm that the effectiveness of emergency preparedness does not depend solely on technical and organizational measures, but also on the level of population preparedness and the ability of the public to respond appropriately to instructions issued by crisis management authorities.

The article confirms the importance of regular training of emergency response units, continuous updating of emergency plans, and ongoing public education in the field of protection during radiological emergencies. An effective emergency preparedness system represents a key instrument for minimizing the consequences of radiological accidents and a significant element in ensuring state security and population protection.

Model scenarios of this type can also serve as a basis for the further development of emergency preparedness, training of the Integrated Rescue System components, and the optimization of protective measures within emergency planning zones.

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Primary Paper Section: A

Secondary Paper Section: AQ

TEAM LEADERSHIP AND BUSINESS NEGOTIATION EFFECTIVENESS IN MULTINATIONAL CORPORATIONS: EVIDENCE FROM SLOVAKIA

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This paper was prepared within the framework of the research project KEGA No. 040EU-4/2024 funded by the Ministry of Education, Research, Development and Youth of the Slovak Republic.

Abstract: Effective team leadership is a key determinant of organisational performance and successful business negotiations in multinational corporations. This study examines the relationship between leadership practices and business negotiation effectiveness in six multinational corporations operating in Slovakia. A mixed-methods research design was employed, combining a questionnaire survey of 304 employees and 51 managers with semi-structured interviews. The findings indicate that open communication, constructive feedback, managerial support, and mutual trust significantly enhance team effectiveness and negotiation outcomes, whereas employee participation in decision-making remains comparatively limited. The study highlights the importance of engaging and participative leadership in strengthening organisational performance and provides practical implications for leadership development, human resource management, and business negotiation training.

Keywords: engaging leadership; participative leadership; multinational corporations; business negotiations; team effectiveness; employee engagement; organisational communication; Slovakia

1 Introduction

The increasing internationalisation of business activities, rapid technological development, and growing market competition have fundamentally transformed the role of leadership in contemporary organisations. In multinational corporations, managers are expected not only to achieve organisational objectives but also to lead culturally diverse teams, promote employee engagement, and create organisational environments that support collaboration, innovation, and effective communication. Consequently, leadership has evolved from a traditional managerial function into a strategic organisational capability that directly influences employee performance, organisational effectiveness, and long-term competitiveness.

Alongside technological and economic changes, organisations are facing increasing demands for flexibility, innovation, and rapid adaptation to changing business environments. These developments have significantly increased the importance of human resource management, particularly in relation to leadership competencies, employee motivation, and organisational communication. Recent leadership research increasingly emphasises that successful organisations are characterised not only by efficient management systems but also by leaders who establish trust-based relationships, encourage employee participation, and create psychologically safe working environments in which employees are willing to share ideas and actively contribute to organisational development.

Within this context, business negotiations represent one of the most important managerial activities. Successful negotiations depend not only on professional expertise and negotiation techniques but also on the leader's ability to coordinate teamwork, facilitate communication, manage conflicts, and establish long-term relationships with business partners. Negotiation outcomes therefore reflect both individual competencies and the overall quality of leadership within an organisation.

Recent international research has increasingly associated leadership effectiveness with concepts such as engaging leadership, participative leadership, employee voice, and team effectiveness. Studies by Mazzetti and Schaufeli (2022), Wang et al. (2022), Yue et al. (2025), and Hamlin et al. (2024) demonstrate that leaders who encourage participation, maintain transparent communication, and strengthen interpersonal trust achieve higher levels of employee engagement, organisational commitment, and team performance. These findings suggest that leadership practices have become an essential determinant of organisational success in multinational corporations operating within culturally diverse environments.

Despite the growing body of international research, empirical evidence focusing specifically on leadership practices in multinational corporations operating in Slovakia remains limited. Existing studies have primarily examined leadership from either a general management perspective or within the broader context of organisational behaviour, while relatively little attention has been devoted to the relationship between team leadership and business negotiation effectiveness. This study seeks to address this research gap by examining how leadership practices influence communication, employee motivation, teamwork, and negotiation outcomes in multinational corporations operating in Slovakia.

The study aims to analyse the relationship between team leadership and business negotiation effectiveness based on empirical evidence obtained from employees and managers working in six multinational corporations operating in Slovakia. By combining quantitative and qualitative research methods, the study identifies key leadership factors that contribute to organisational performance and successful business negotiations. In addition to its theoretical contribution, the study provides practical recommendations for managers, human resource professionals, and higher education institutions responsible for developing future business leaders.

2 Literature Review

2.1 Team Leadership in Contemporary Organisations

Leadership has become one of the most extensively researched topics in management and organisational behaviour over the past decades. Contemporary organisations operate in increasingly dynamic, globalised, and technology-driven environments, requiring leaders to perform roles that extend far beyond traditional managerial functions. Rather than merely supervising employees and coordinating operational activities, modern leaders are expected to inspire teams, facilitate communication, promote innovation, and create organisational cultures based on trust, collaboration, and continuous learning.

The concept of team leadership refers to a leader's ability to coordinate the activities of a group while simultaneously supporting individual development and achieving collective organisational goals. Effective team leaders establish clear objectives, define responsibilities, provide constructive feedback, resolve conflicts, and encourage knowledge sharing among team members. These leadership behaviours contribute directly to employee engagement, organisational commitment, and overall team performance.

Classical management literature has long recognised leadership as one of the principal determinants of organisational success. Mintzberg (1973) identified interpersonal, informational, and decisional roles as the fundamental responsibilities of managers. According to his framework, effective managers continuously communicate with employees, coordinate organisational activities, represent the organisation externally, and make strategic decisions under conditions of uncertainty. Although developed several decades ago, Mintzberg's managerial roles remain highly relevant in today's multinational business environment.

More recent leadership research has shifted attention from hierarchical authority towards relationship-oriented leadership models. Leaders are increasingly viewed as facilitators who create favourable conditions for employee development rather

than merely directing work activities. Consequently, leadership effectiveness is now associated with employees' psychological well-being, engagement, collaboration, and willingness to contribute proactively to organisational objectives.

One of the most influential contemporary concepts is engaging leadership, which emphasises the leader's ability to strengthen interpersonal relationships, foster mutual trust, and create meaningful work experiences. According to Mazzetti and Schaufeli (2022), engaging leadership significantly improves team effectiveness by increasing employee engagement, strengthening communication, and enhancing trust between managers and employees. Their longitudinal study further demonstrated that supportive leadership behaviours indirectly improve organisational performance through the development of both individual and team resources.

Similarly, the concept of participative leadership has gained increasing attention in recent years. Wang, Hou, and Li (2022) argue that leaders who actively involve employees in organisational decision-making create higher levels of motivation, organisational commitment, and innovation. Their comprehensive literature review concludes that employee participation not only improves decision quality but also strengthens organisational adaptability in rapidly changing business environments. These findings suggest that leadership effectiveness increasingly depends on collaboration rather than hierarchical authority.

Another important aspect of contemporary leadership concerns organisational communication. Yue, Thelen, and Verghese (2025) demonstrated that transparent supervisory communication significantly increases employees' willingness to express opinions, share innovative ideas, and participate in organisational improvement initiatives. Their research highlights employee voice as an important indicator of healthy organisational culture and effective leadership. Organisations where employees feel psychologically safe are generally characterised by stronger teamwork, greater innovation, and higher organisational performance.

The international dimension of leadership has also become increasingly important due to the growing number of multinational corporations operating across culturally diverse environments. Hamlin, Alhejji, and Patel (2024) emphasise that leadership effectiveness depends not only on managerial competencies but also on leaders' ability to understand cultural diversity, adapt communication styles, and establish trust across different cultural contexts. These competencies have become indispensable for organisations operating internationally, where managers frequently lead multicultural teams and negotiate with partners representing diverse cultural backgrounds.

Overall, contemporary leadership research consistently demonstrates that effective team leadership is built upon communication, employee participation, trust, continuous learning, and relationship-oriented management. These dimensions provide the theoretical foundation for the present study and serve as the basis for analysing leadership practices in multinational corporations operating in Slovakia.

2.2 Leadership in Multinational Corporations

Leadership in multinational corporations presents significantly greater challenges than leadership in domestic organisations due to the complexity of international business operations, cultural diversity, and geographically dispersed teams. Managers working in multinational environments are expected to integrate employees with different cultural backgrounds, communication styles, and professional experiences while simultaneously ensuring that organisational objectives are achieved efficiently and consistently across international subsidiaries.

Globalisation has fundamentally transformed managerial responsibilities by increasing the importance of intercultural communication and collaborative leadership. Modern multinational corporations increasingly rely on cross-functional and multicultural teams whose effectiveness depends largely on leaders' ability to establish trust, encourage collaboration, and facilitate knowledge sharing. Consequently, leadership is no longer viewed solely as a managerial function but rather as a strategic organisational capability that enables companies to remain competitive in international markets.

One of the distinguishing characteristics of multinational corporations is the necessity to balance global corporate strategies with local organisational practices. Leaders must therefore combine standardised management principles with sufficient flexibility to accommodate national cultural differences and local labour market conditions. Research indicates that organisations capable of integrating global organisational values with culturally sensitive leadership practices achieve higher employee satisfaction, stronger organisational commitment, and improved business performance.

Intercultural leadership has become particularly important in business negotiations involving international partners. Managers frequently negotiate with individuals representing different negotiation styles, communication preferences, and decision-making processes. Effective leaders therefore require not only professional expertise but also cultural intelligence, emotional intelligence, and advanced interpersonal communication skills. These competencies reduce the likelihood of misunderstandings, facilitate cooperation, and strengthen long-term business relationships.

The importance of ethical leadership has also increased considerably in multinational organisations. Employees increasingly expect leaders to demonstrate integrity, fairness, transparency, and social responsibility. Organisations that promote ethical leadership generally experience higher employee trust, stronger organisational commitment, and lower staff turnover. These factors contribute not only to organisational stability but also to the credibility of organisations during international business negotiations.

Recent leadership theories therefore emphasise that successful multinational corporations require leaders capable of integrating strategic thinking with effective communication, employee development, cultural awareness, and ethical decision-making. These competencies are particularly relevant for organisations operating in Slovakia, where multinational corporations represent an important component of the national economy and employ thousands of professionals working in culturally diverse environments.

2.3 Leadership and Business Negotiation Effectiveness

Business negotiations represent one of the most important strategic activities within multinational corporations, as they directly influence organisational performance, long-term partnerships, and competitive advantage. Although negotiation outcomes are often associated with individual negotiation skills, contemporary research increasingly emphasises that successful negotiations depend on effective leadership, teamwork, and organisational communication. Leaders play a pivotal role in preparing negotiation teams, coordinating internal communication, allocating responsibilities, and creating an environment that enables collaborative decision-making throughout the negotiation process.

Traditional negotiation theory primarily focused on bargaining strategies and individual negotiation competencies. Lax and Sebenius (1986) argue that successful negotiations require not only analytical preparation but also the ability to manage relationships, balance conflicting interests, and create value for all negotiating parties. Similarly, contemporary management literature recognises negotiation as a collaborative process in which leadership behaviour significantly influences both negotiation processes and outcomes.

Effective leaders contribute to negotiation success by establishing clear objectives, encouraging knowledge sharing, and ensuring that negotiation teams operate cohesively. Within multinational corporations, negotiation teams frequently consist of employees representing different functional areas, including sales, finance, legal affairs, logistics, and marketing. Consequently, leadership effectiveness depends on the ability to coordinate interdisciplinary expertise while maintaining efficient communication and mutual trust among team members.

Recent leadership research has further demonstrated that organisational communication constitutes one of the strongest predictors of successful negotiations. Yue et al. (2025) found that transparent supervisory communication encourages employees to express ideas, share professional knowledge, and participate actively in organisational improvement initiatives. Such communication strengthens employee voice, which has been identified as a critical factor supporting organisational learning, innovation, and collaborative decision-making. Negotiation teams characterised by open communication are generally better prepared to respond to unexpected challenges, evaluate alternative solutions, and achieve mutually beneficial agreements.

Employee participation has also emerged as an important determinant of negotiation effectiveness. According to Wang et al. (2022), participative leadership enhances employees' motivation, organisational commitment, and willingness to contribute actively to decision-making processes. When employees perceive that their opinions are respected and considered, they demonstrate higher levels of responsibility, initiative, and engagement. These characteristics become particularly valuable during business negotiations, where flexibility, creativity, and rapid problem-solving frequently determine negotiation success.

Furthermore, engaging leadership contributes indirectly to negotiation effectiveness by strengthening interpersonal trust and team cohesion. Mazzetti and Schaufeli (2022) demonstrated that leaders who provide continuous feedback, recognise employee contributions, and support professional development create highly engaged teams capable of achieving superior organisational performance. Such leadership behaviours are particularly relevant during complex negotiations requiring intensive collaboration, coordinated decision-making, and sustained commitment to common organisational objectives.

Leadership effectiveness within multinational corporations also depends on leaders' ability to manage cultural diversity. International negotiations frequently involve business partners representing different national cultures, communication styles, and organisational practices. Hamlin et al. (2024) emphasise that successful leaders demonstrate cultural sensitivity, adaptability, and ethical behaviour while maintaining consistent organisational values. These competencies strengthen organisational credibility, facilitate international cooperation, and contribute to the development of long-term strategic partnerships.

Overall, contemporary literature suggests that business negotiation effectiveness should not be viewed solely as the result of individual negotiation competencies but rather as the outcome of effective team leadership, transparent communication, employee participation, and collaborative organisational cultures. These theoretical assumptions provide an important framework for interpreting the empirical findings presented in this study.

2.4 Research Gap

Although leadership has been extensively investigated within the fields of management and organisational behaviour, several important research gaps remain. Previous studies have predominantly examined leadership styles, employee motivation, organisational commitment, or communication as separate research topics. Comparatively less attention has been devoted to analysing the relationship between team leadership and business negotiation effectiveness, particularly within multinational corporations operating in Central and Eastern Europe.

Recent international studies have demonstrated positive relationships between engaging leadership, participative leadership, employee voice, and team effectiveness (Mazzetti & Schaufeli, 2022; Wang et al., 2022; Yue et al., 2025). Similarly, research conducted in multinational organisations has highlighted the growing importance of intercultural leadership and ethical managerial behaviour in culturally diverse working environments (Hamlin et al., 2024). Nevertheless, empirical evidence examining how these leadership dimensions influence business negotiations remain relatively limited.

Another limitation of the existing literature concerns geographical context. Most contemporary studies have been conducted in Western Europe, North America, or Asia, whereas comparatively little empirical evidence is available regarding multinational corporations operating in Slovakia and neighbouring Central European countries. As multinational corporations constitute an important component of the Slovak economy, examining leadership practices within this context may contribute valuable insights into both leadership research and international business management.

The present study addresses these research gaps by investigating the relationship between team leadership and business negotiation effectiveness in six multinational corporations operating in Slovakia. Unlike many previous studies that focus exclusively on employees or managers, this research combines the perspectives of both groups through a mixed-methods research design. Quantitative data obtained from questionnaire surveys are complemented by qualitative evidence from semi-structured interviews, allowing for a more comprehensive understanding of leadership practices in multinational organisations.

The study therefore contributes to the existing body of knowledge in three principal ways. First, it extends current leadership research by integrating leadership theory with the field of business negotiations. Second, it provides empirical evidence from multinational corporations operating in Slovakia, a context that has received limited scholarly attention in the international literature. Finally, the study offers practical recommendations for managers, human resource professionals, and higher education institutions responsible for developing future leaders capable of managing multicultural teams and conducting effective business negotiations.

3 Materials and Methods

3.1 Research Design

This study employed a mixed-methods research design combining quantitative and qualitative research approaches to obtain a comprehensive understanding of leadership practices and their influence on business negotiation effectiveness in multinational corporations operating in Slovakia. The quantitative component consisted of a questionnaire survey administered to employees and managers, while the qualitative component comprised semi-structured interviews designed to provide deeper insights into leadership behaviour, organisational communication, and negotiation practices.

The mixed-methods approach was selected because it enables the integration of numerical data with participants' subjective experiences, thereby increasing the validity and comprehensiveness of the research findings. Combining questionnaire responses with interview data also facilitated the triangulation of evidence, allowing the quantitative findings to be interpreted within the broader organisational context.

The study was conducted within the framework of the KEGA research project No. 040EU-4/2024, funded by the Ministry of Education, Research, Development and Youth of the Slovak

Republic. The project focuses on the development of managerial, communication, and negotiation competencies through the modernisation of higher education and empirical research conducted in cooperation with multinational corporations operating in Slovakia.

3.2 Research Sample

The empirical research was carried out in six multinational corporations with subsidiaries operating in Slovakia, representing different sectors of the economy, including information technology, manufacturing, retail, telecommunications, and the fashion industry. The participating organisations were IBM, Dell Technologies, Wilo, Lidl, Orange Slovakia, and Calzedonia Group. These companies were selected because of their international business activities, culturally diverse workforces, and extensive experience in international business negotiations.

A total of 502 electronic questionnaires were distributed among employees working in the selected corporations. 304 completed questionnaires were returned, representing a response rate of 60.8%. The employee sample consisted of 220 women (72.4%) and 84 men (27.6%), ranging in age from 19 to 64 years. The largest proportion of respondents belonged to the 31–40 years age group, followed by employees aged 21–30 years.

The respondents represented the following multinational corporations:

IBM (n = 78)
Dell Technologies (n = 60)
Wilo (n = 14)
Lidl (n = 28)
Orange Slovakia (n = 39)
Calzedonia Group (n = 85)

In addition to employees, the study also included 51 managers and team leaders, enabling the comparison of managerial and employee perspectives on leadership practices. The managerial sample consisted of participants aged 38 to 68 years, with most respondents belonging to the 41–50 years age category. The inclusion of both employees and managers provided a more balanced understanding of organisational leadership and reduced the risk of relying exclusively on one stakeholder group's perceptions.

3.3 Research Instruments

Data were collected using two complementary research instruments: a structured questionnaire and semi-structured interviews.

The questionnaire consisted of demographic questions together with items measuring employees' and managers' perceptions of leadership practices, organisational communication, employee motivation, teamwork, feedback, participation in organisational decision-making, and selected aspects of business negotiations. Most questionnaire items employed a six-point Likert scale, where 0 indicated strong disagreement and 5 indicated strong agreement. The absence of a neutral response option encouraged respondents to express either a positive or a negative evaluation of each statement.

The managerial questionnaire included 17 statements evaluating leadership behaviour across several dimensions, including communication, performance management, employee motivation, organisational support, participation in organisational changes, and interpersonal relationships within work teams.

To complement the quantitative findings, semi-structured interviews were conducted with selected managers and employees. The interviews focused primarily on leadership practices, organisational culture, communication processes, employee engagement, and experiences related to business negotiations. This qualitative component enabled respondents to explain their questionnaire responses in greater detail and provided additional contextual information supporting the interpretation of quantitative findings.

3.4 Data Collection and Analysis

Data collection was conducted electronically during the implementation of the KEGA research project. Participation in the study was voluntary, and respondents were informed about the purpose of the research and the anonymous processing of all collected data. No personally identifiable information was recorded, ensuring respondents' confidentiality and encouraging honest responses.

Quantitative data obtained from the questionnaires were analysed using descriptive statistical methods, including frequency distributions, percentages, arithmetic means, and graphical presentation of results. These methods enabled the identification of dominant leadership characteristics and the comparison of employees' and managers' perceptions regarding leadership effectiveness.

The qualitative interview data were analysed using thematic analysis. Individual interview transcripts were systematically reviewed to identify recurring themes related to leadership behaviour, communication, employee motivation, teamwork, and business negotiations. The qualitative findings were subsequently integrated with the quantitative results, providing a more comprehensive interpretation of leadership practices within the participating multinational corporations.

3.5 Ethical Considerations

The study adhered to generally accepted ethical principles governing social science research. Participation was entirely voluntary, respondents provided informed consent prior to completing the questionnaire or participating in interviews, and all responses were treated confidentially. The collected data were analysed exclusively for scientific purposes within the framework of the KEGA research project and were reported only in aggregated form to ensure participants' anonymity.

4 Results

4.1 Characteristics of the Research Sample

The empirical research involved employees and managers from six multinational corporations operating in Slovakia across the information technology, manufacturing, retail, telecommunications, and fashion industries. A total of 304 employees completed the questionnaire, representing a response rate of 60.8% from the 502 distributed questionnaires. In addition, 51 managers and team leaders participated in the study, providing complementary perspectives on leadership practices within their organisations.

The employee sample consisted predominantly of women (72.4%), while men represented 27.6% of respondents. Participants ranged in age from 19 to 64 years, with the largest proportion belonging to the 31–40 years age category. This demographic profile reflects the age structure typically observed in multinational corporations operating in Slovakia, where most employees occupy professional and middle-management positions.

The participating organisations included IBM, Dell Technologies, Wilo, Lidl, Orange Slovakia, and Calzedonia Group. The inclusion of organisations from different industries increased the diversity of the research sample and enabled the identification of leadership characteristics that extend across different organisational contexts.

4.2 Leadership Practices in Multinational Corporations

The questionnaire results indicate that respondents generally evaluated leadership practices positively, particularly in relation to communication, managerial support, and performance feedback. Managers reported that they regularly informed employees about their work performance, discussed individual achievements, and addressed performance-related issues in a timely manner. These findings suggest that performance management and feedback constitute well-established leadership practices within the participating multinational corporations.

Constructive feedback emerged as one of the strongest dimensions of leadership effectiveness. Respondents emphasised that regular communication regarding work performance contributed to greater role clarity, stronger motivation, and improved cooperation between managers and employees. These findings support the assumption that effective feedback enhances both individual performance and overall team effectiveness.

Managers also reported that they actively encouraged employees to improve their performance and provided assistance when work-related problems occurred. Such supportive leadership behaviour contributes to the development of interpersonal trust, which has been widely recognised as an essential prerequisite for effective teamwork and organisational commitment.

4.3 Employee Participation and Organisational Communication

Although respondents evaluated communication positively, the findings also revealed several areas requiring improvement. Lower scores were observed for questionnaire items related to employee participation in organisational decision-making and communication during organisational change.

Many respondents indicated that they were not consistently involved in decisions affecting their daily work or organisational development. Similarly, managers acknowledged that employees were not always consulted before organisational changes were implemented, nor was sufficient attention consistently devoted to ensuring that employees fully understood the reasons for these changes.

These findings suggest that communication within the participating corporations remains predominantly top-down, while opportunities for participative decision-making remain comparatively limited. Considering the increasing complexity of multinational organisations, greater employee involvement may contribute to stronger organisational commitment, improved innovation, and more effective implementation of organisational change.

4.4 Leadership and Team Effectiveness

The results demonstrate a clear relationship between leadership behaviour and perceived team effectiveness. Respondents who evaluated managerial communication, feedback, and support positively also reported higher levels of teamwork, cooperation, and employee motivation.

The findings indicate that leadership effectiveness is not determined solely by managers' ability to coordinate work activities but also by their capacity to establish trusting relationships and create psychologically supportive working environments. Employees who perceived their managers as approachable and supportive were more willing to cooperate with colleagues, share professional knowledge, and contribute to organisational objectives.

Furthermore, respondents emphasised that effective leaders encouraged open communication and facilitated constructive problem-solving within work teams. Such leadership practices strengthen organisational resilience and improve the ability of teams to respond effectively to changing business conditions.

4.5 Leadership and Business Negotiation Effectiveness

One of the principal objectives of this research was to examine the relationship between leadership practices and business negotiation effectiveness. Although the questionnaire did not measure negotiation performance directly, both questionnaire responses and interview findings indicate that leadership competencies substantially influence the organisational conditions necessary for successful negotiations.

Managers participating in the interviews consistently highlighted communication, preparation, teamwork, and mutual trust as critical success factors in business negotiations. They emphasised that negotiation outcomes depend not only on the competencies of individual negotiators but also on the quality of internal cooperation before, during, and after negotiations.

Several interview participants noted that effective leaders ensure that negotiation teams clearly understand organisational objectives, possess the necessary information, and communicate consistently throughout the negotiation process. Such preparation reduces misunderstandings, strengthens organisational credibility, and improves the likelihood of achieving mutually beneficial agreements.

The findings therefore suggest that leadership contributes to negotiation effectiveness indirectly through the creation of organisational environments characterised by trust, collaboration, knowledge sharing, and effective communication.

4.6 Summary of Key Findings

Overall, the empirical findings identify four principal determinants of leadership effectiveness within multinational corporations operating in Slovakia:

transparent organisational communication;
constructive and continuous performance feedback;
managerial support and mutual trust;
employee motivation and effective teamwork.

Conversely, employee participation in organisational decision-making and communication during organisational change remain comparatively weaker dimensions of leadership practice. These findings indicate that multinational corporations may further strengthen organisational performance by adopting more participative leadership approaches that actively involve employees in organisational processes.

The results presented in this chapter provide the empirical foundation for the subsequent discussion, where the findings are compared with recent international research on engaging leadership, participative leadership, employee voice, and leadership effectiveness in multinational corporations.

5 Discussion

The present study examined the relationship between team leadership and business negotiation effectiveness in multinational corporations operating in Slovakia. The findings indicate that effective leadership extends beyond the coordination of daily work activities and plays a strategic role in shaping organisational communication, employee engagement, teamwork, and negotiation performance.

One of the principal findings concerns the importance of transparent communication and constructive feedback. Respondents consistently identified regular communication, managerial support, and continuous performance feedback as the strongest characteristics of effective leadership. These findings are consistent with the concept of engaging leadership proposed by Mazzetti and Schaufeli (2022), who demonstrated that leaders strengthen team effectiveness by creating supportive working environments characterised by trust, communication, and employee development. Similarly, the present study confirms

that employees who perceive their managers as supportive and approachable report higher levels of motivation and cooperation.

The research also revealed comparatively lower evaluations of employee participation in organisational decision-making and organisational change. This finding supports the conclusions of Wang, Hou, and Li (2022), whose comprehensive review identifies participative leadership as a critical determinant of employee commitment, innovation, and organisational adaptability. Their work suggests that involving employees in decision-making improves both decision quality and organisational performance. The present findings indicate that multinational corporations operating in Slovakia could further strengthen leadership effectiveness by expanding opportunities for employee participation.

Communication emerged as another key determinant of organisational effectiveness. Employees emphasised the importance of open dialogue, timely information sharing, and constructive interpersonal relationships. These findings correspond closely with Yue, Thelen, and Verghese (2025), who found that transparent supervisory communication encourages employee voice, enabling employees to share ideas, propose improvements, and participate more actively in organisational development. The current study likewise demonstrates that communication is fundamental to trust-building and effective teamwork.

The international context of the research further highlights the importance of culturally sensitive leadership. Hamlin, Alhejji, and Patel (2024) argue that leadership effectiveness within multinational corporations depends not only on managerial competencies but also on leaders' ability to adapt their behaviour to organisational and cultural contexts. Although the present study did not specifically examine cultural differences, the participating organisations operate in multicultural environments where communication, ethical leadership, and interpersonal trust are essential prerequisites for successful cooperation and business negotiations.

Another important contribution of the study concerns business negotiation effectiveness. Rather than viewing negotiations solely as individual managerial activities, the findings demonstrate that successful negotiations are supported by high-quality teamwork, effective internal communication, and coordinated leadership. Managers participating in the interviews repeatedly emphasised that careful preparation, information sharing, and clearly defined organisational objectives contribute substantially to successful negotiation outcomes. These findings extend previous leadership research by integrating organisational leadership with the field of business negotiations.

From a theoretical perspective, the study contributes to the growing body of research on leadership in multinational corporations by combining concepts of engaging leadership, participative leadership, employee voice, and team effectiveness within a single empirical framework. From a practical perspective, the findings suggest that organisations should invest not only in negotiation training but also in leadership development programmes that strengthen communication competencies, employee participation, and collaborative organisational cultures.

Overall, the findings demonstrate that leadership effectiveness should be understood as a multidimensional organisational capability that directly influences employee engagement, team performance, and business negotiation effectiveness. Organisations capable of integrating these dimensions into everyday managerial practice are better positioned to establish sustainable competitive advantages in increasingly dynamic international business environments.

6 Conclusions

This study investigated the relationship between team leadership and business negotiation effectiveness in multinational corporations operating in Slovakia. Drawing on a mixed-methods research design that combined questionnaire data from 304 employees and 51 managers with semi-structured interviews, the study identified the leadership practices that most strongly influence communication, teamwork, employee engagement, and negotiation performance.

The findings demonstrate that transparent communication, constructive feedback, managerial support, and interpersonal trust represent the principal determinants of effective leadership. Conversely, employee participation in organisational decision-making and organisational change remains comparatively limited, indicating opportunities for further leadership development within multinational corporations.

From a theoretical perspective, the study contributes to contemporary leadership research by integrating concepts of engaging leadership, participative leadership, employee voice, team effectiveness, and business negotiation effectiveness into a unified analytical framework. The research also extends existing empirical evidence by focusing on multinational corporations operating in Slovakia, a geographical context that remains underrepresented in the international leadership literature.

The study also provides several practical implications for managers and human resource professionals. Organisations should encourage participative leadership, strengthen internal communication, promote employee involvement in decision-making, and invest in continuous leadership development. Such initiatives may improve employee engagement, organisational commitment, teamwork, and ultimately increase the effectiveness of business negotiations.

Several limitations should be acknowledged. The research focused exclusively on multinational corporations operating in Slovakia, which may limit the generalisability of the findings to other organisational and cultural contexts. In addition, the study employed primarily descriptive statistical techniques and relied on self-reported perceptions of employees and managers.

Future research should examine leadership practices across different industries and countries, employ longitudinal research designs, and incorporate advanced statistical methods to explore causal relationships between leadership behaviour, organisational communication, and negotiation effectiveness. Comparative international studies would further contribute to understanding how cultural differences influence leadership practices and business negotiations within multinational corporations.

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Primary Paper Section: A

Secondary Paper Section: AN, GM, CF

REVISITING THE U.S. EMERGENCY MANAGEMENT SYSTEM: A CRITICAL ANALYSIS OF THE MONOGRAPH *U.S. EMERGENCY MANAGEMENT IN THE 21ST CENTURY: FROM DISASTER TO CATASTROPHE* BY THE BOOK'S AUTHORS CUTTER, GALL, AND RUBIN

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if applicable, please specify whether the paper is published within the frame of any grant, university research etc. (Times New Roman, Font 6)

Abstract: The monograph U.S. Emergency Management in the 21st Century: From Disaster to Catastrophe, published in 2025, examines the current structure, functioning, and limitations of the U.S. emergency management system at a time of escalating emergencies and crises. The authors combine empirical case studies (e.g., Hurricane Katrina, major tornadoes, and extensive wildfires in California) with an analysis of crisis management responses to these emergencies and disasters. In doing so, they evaluate the development of crisis policy in the United States, the role of FEMA (Federal Emergency Management Agency), the National Incident Management System (NIMS), and mechanisms of multi-level governance. From a legislative, legal, and institutional perspective, the monograph highlights the fragmentation of authority and the challenges associated with achieving effective integration in the absence of a unified legal framework. As such, the publication provides a valuable comparative basis for the study of integrated emergency response systems in other countries, including the Czech Republic. Although the monograph is positively evaluated for its clear writing style and empirical depth, it has also been criticized for its limited theoretical innovation and its more descriptive than explanatory analytical approach.

Keywords: Emergency management, integrated rescue system, U.S. emergency system, soft integration, formal integration, multi-level governance, Federal emergency management (FEMA), National Incident Management System (NIMS), comparative analysis, risk governance, disaster resilience, institutional fragmentation

1 CONCEPTUAL FRAMEWORK AND THEORETICAL FOCUS

The authors adopt the "hazard-risk-vulnerability" paradigm as the primary interpretative framework for understanding the emergency management system in the United States. Contemporary disasters are therefore understood not merely as natural phenomena, but as sociotechnical processes shaped by demographic development, land-use patterns, infrastructure, and public administration structures.

This perspective aligns the monograph with broader developments in disaster management theory, which has gradually shifted from a reactive and event-driven model toward a systemic understanding emphasizing resilience, preparedness, mitigation, and adaptive capacity.

The monograph relies primarily on an applied conceptual framework rather than on the development of an original theoretical model. The authors draw upon established concepts such as risk governance, institutional resilience, and multi-level governance. As a result, the book remains accessible to practitioners and policymakers; however, this accessibility somewhat limits its theoretical contribution.

Readers with legal or political science backgrounds will appreciate the publication's normative insights, although the text contains relatively few clearly defined analytical categories regarding institutional, legal, or organizational barriers in emergency management.

2 METHODOLOGY AND EMPIRICAL CERTAINTY

The methodological approach of the monograph can best be described as a case-study-oriented policy analysis.

The book examines numerous major disasters, including tornadoes (Joplin, Tuscaloosa-Birmingham, Moore), hurricanes (Sandy, Harvey, Irma, Maria), and California wildfires. These cases form the empirical basis for evaluating both the successes and failures of the U.S. emergency management system.

The use of case studies enables the authors to provide contextually rich insights into interactions among local, state, and federal institutions, including FEMA, NIMS, and the Incident Command System (ICS). Nevertheless, the monograph also demonstrates several methodological limitations.

Case selection appears influenced primarily by media visibility and political significance rather than by a systematically defined sampling strategy. Consequently, the analysis risks overemphasizing highly publicized disasters while underrepresenting smaller yet structurally important emergencies.

Moreover, the integration of qualitative and quantitative data remains largely descriptive and is not sufficiently incorporated into a coherent analytical framework. The publication also fails to employ comparative case-study logic capable of isolating causal mechanisms behind successful or unsuccessful emergency responses.

From a critical academic perspective, the empirical strength of the publication lies primarily in the richness of its narrative and the policy-relevant lessons it offers, rather than in its contribution to rigorous causal explanation.

3 LEGAL AND GOVERNANCE ARCHITECTURE OF CRISIS MANAGEMENT

From the perspective of public law, the publication provides a valuable, albeit somewhat implicit, critique of the American legal framework for emergency management.

The authors repeatedly emphasize the fragmentation of authority among federal, state, and local actors, as well as the tensions between legal competence, institutional practice, and political responsibility.

Particularly significant is the analysis of FEMA's evolving role, which demonstrates how policy changes during the Trump administration contributed to the institutional weakening of the federal emergency management system's capabilities**,** including reductions in staffing capacity and strategic preparedness.

The publication implicitly addresses key public law concepts such as subsidiarity, federalism, and accountability; however, these concepts are not systematically theorized. A more legally focused analysis might have explored questions concerning the enforceability of federal obligations, judicial review of discretionary emergency decisions, or compensation mechanisms following catastrophic events.

Consequently, the monograph functions more as a sociological and policy-oriented analysis than as a fully developed legal-institutional study, despite providing substantial material for further legal interpretation.

4 ESTABLISHMENT OF AN INTEGRATED RESCUE SYSTEM

Throughout the monograph, the authors repeatedly emphasize the importance of interagency coordination, information sharing, and unified command structures based on NIMS and ICS. At the same time, however, they point to the persistent operational limitations of these systems during real-time emergency response operations.

The publication documents recurring problems related to interagency communication, overlapping jurisdictions, and differing levels of preparedness and training among participating agencies.

Conceptually, the book implicitly aligns with the understanding of an integrated emergency response system as a network of

formally distinct yet functionally interdependent actors. Nevertheless, it does not define this concept with the same degree of terminological precision characteristic of Czech legislation governing the Integrated Rescue System.

The American emergency management framework can therefore be described as functionally integrated but formally fragmented. From the perspective of comparative legal analysis, the publication thus provides valuable indirect evidence regarding the extent to which integration may be achieved through governance mechanisms, operational coordination, and institutional practice rather than through a unified legal structure.

5 STRENGTHS AND WEAKNESSES OF THE PUBLICATION

For researchers and experts engaged in the comparative study of emergency management and integrated rescue systems, the principal strengths of the monograph lie in its empirical depth and policy-oriented analytical approach.

The publication provides a detailed and up-to-date account of the functioning of a highly decentralized emergency management system operating under conditions of increasing environmental and societal risk. The inclusion of recent disasters — particularly Hurricane Maria in Puerto Rico and the California wildfires — adds significant contemporary relevance to the analysis and illustrates the adaptation pressures confronting modern emergency management systems.

The concluding chapters of the monograph are explicitly devoted to identifying the shortcomings of the current system and outlining possible directions for future reform.

The authors identify three major interconnected challenges facing the United States:

1. the increasing scale and frequency of catastrophic events;
2. the institutional weakening of the federal emergency management system's capabilities; and
3. growing inequalities in societal vulnerability and post-disaster recovery outcomes.

In response to these challenges, the authors advocate for a more adaptive, resilient, and equitable emergency management system. They emphasize the necessity of long-term investments in mitigation strategies, community preparedness, and integrated recovery planning.

From a critical scholarly perspective, several aspects of this policy agenda deserve closer examination.

First, the authors' criticism of federal austerity measures occasionally appears politically prescriptive rather than analytically neutral. While this rhetorical approach strengthens the publication's persuasive impact, it simultaneously weakens the methodological objectivity expected from an academic monograph.

Second, the proposed reforms remain predominantly programmatic and insufficiently institutionalized. The authors repeatedly call for improved coordination, enhanced planning mechanisms, and stronger community engagement; however, they do not adequately elaborate on the legislative, administrative, or budgetary instruments necessary to implement these objectives effectively.

At the same time, the limitations of the publication are equally significant. The relatively limited degree of theoretical innovation, uneven methodological rigor, and insufficient engagement with legal-institutional analysis reduce the monograph's value as a standalone source for advanced comparative legal research.

The publication is therefore best understood as a supplementary analytical resource illustrating the operational reality of a highly fragmented yet operationally interconnected emergency management system, rather than as a comprehensive doctrinal or theoretical work.

For scholars focusing on the Czech Integrated Rescue System, the monograph primarily serves as a comparative reference point illustrating the contrast between a legally integrated but operationally complex system and a system that is operationally integrated but legally fragmented.

For readers familiar with public law theory, the book ultimately functions more as a diagnostic manifesto concerning the present condition of American emergency management than as a detailed institutional blueprint for reform.

6 OVERALL EVALUATION AND SCIENTIFIC CONTRIBUTION OF THE MONOGRAPH

Overall, *U.S. Emergency Management in the 21st Century: From Disaster to Catastrophe* represents a timely and intellectually relevant - albeit ultimately introductory, contribution to the academic and professional literature on emergency management.

Its principal value lies in synthesizing a broad spectrum of empirical evidence into a coherent account of the systemic vulnerabilities and institutional pathologies characterizing the U.S. emergency management system.

The publication successfully demonstrates the urgency of structural reform while simultaneously making the highly specialized field of emergency management more accessible to a broader audience, including students, practitioners, and policymakers.

From a critical academic perspective, however, the monograph does not provide a fully theorized, methodologically rigorous, or legally explicit analysis of the fundamental structures of emergency management governance.

For legal scholars interested in the comparative architecture of integrated emergency response systems, the publication should therefore be regarded primarily as a valuable empirical supplement suitable for secondary analysis — particularly in comparison with other national systems, including the Czech Integrated Rescue System — rather than as an independent theoretical foundation.

Despite these limitations, the monograph remains a useful and intellectually stimulating contribution to contemporary discussions concerning crisis governance, institutional resilience, and the future evolution of emergency management systems in democratic states.

Literature:

1. CUTTER, Susan L.; GALL, Melanie a RUBIN, Claire B. *U.S. emergency management in the 21st century: from disaster to catastrophe*. 2nd edition. New York, NY: Routledge, 2025. ISBN 978-1032970509.

Primary Paper Section: A

Secondary Paper Section: AE, AQ

A SYSTEMATIC LITERATURE REVIEW: ASPECTS OF ARTIFICIAL INTELLIGENCE USE IN THE SELF-DIRECTED LEARNING PROCESS OF GENERATION Z

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Abstract: The aim of this paper is to identify and synthesize the positive and negative aspects of using artificial intelligence (AI) in the self-directed learning process of Generation Z. The paper is structured as a systematic literature review following the PRISMA framework, with the analysis based on the thematic synthesis method of Thomas and Harden (2008). The findings suggest that artificial intelligence can function as a safe and personalized tutor within the process of self-directed learning, supporting the development of metacognition and having a positive impact on both cognitive and affective components of learning, provided that it is used as a so-called "scaffold", i.e. as a support for thinking, and not as a replacement for one's own cognitive work. At the same time, the findings show that excessive reliance on AI tools can lead to cognitive passivity, weakened critical thinking, and plagiarism. Further risks include inaccurate or outdated AI outputs, students' insufficient AI literacy, and ethical dilemmas related to authorship and algorithmic bias. The effectiveness of AI-supported self-directed learning therefore depends primarily on students' critical and reflective approach to its use.

Keywords: Generation Z. Self-directed learning. Artificial intelligence. AI. Education.

1 Introduction

Young people born between 1997 and 2012, also referred to as Generation Z, are currently considered the first generational cohort to grow up with unlimited access to digital technologies, which later became an inseparable part of their lives (Evidence In Motion, 2024). As early as 2010, the prominent Australian sociologist Mark McCrindle stated that the age at which we first use technology determines how deeply it becomes embedded in our lifestyle. He regards Generation Z as so-called *"digital integrators,"* since these young people have used technology from an early age and have managed to integrate it seamlessly into nearly every area of their lives (McCrindle & Wolfinger, 2009). This everyday entanglement with technology has fundamentally shaped their thinking, preferences, and the way they learn (Evidence In Motion, 2024). Digital technologies substantially transform the cognitive functions and learning habits of Generation Z by reshaping their neurological engagement and the way they process information, which can also have various negative effects. These may include, for example, difficulty building deeper causal connections, a reduced capacity for systems thinking — which requires 23 minutes of uninterrupted concentration — a marked reduction in attention span and the ability to concentrate, and a decline in the ability to perform more complex analytical work (Sureshkumar, 2025). This is further confirmed by an extensive meta-analysis showing that research from recent years in the field of neurophysiology demonstrates changes in the activity of brain structures responsible for systems, critical, and analytical thinking. *"Media convergence"* [1] has caused society to shift rapidly from a *"reading"* generation to a *"watching"* one. A large proportion of online information now exists in purely visual or audiovisual form. At the same time, the human brain fundamentally gravitates toward simpler solutions — that is, toward visual or simple textual content (Vasilyeva, 2021). These facts are also largely reflected in the preferences of the digital generation. Members of Generation Z indeed prefer social media platforms that offer content in the form of short videos, most notably TikTok, Instagram, and YouTube (Pew Research Center, 2024). These young people favor content that is fast, visual, and flexible. Vertical videos with captions, background music, and a narrative style work best for them, since Generation Z primarily consumes content on mobile devices, often without sound. A content creator who explains *"how to save money during college"* in a 45-second video using on-screen text and real-life examples can capture far more attention than a long written post. Such videos are easy to watch, simple to share, and ideally suited to algorithm-driven platforms (Egnoto, 2026). Similar findings are demonstrated by the comparative study of Pandey et al. (2025). The results suggest that short-form video content represents a significant part of the everyday lives of Generation Z members, not only in terms of consumption but also of content creation (Pandey et al., 2025). However, the consumption of short video content on platforms such as TikTok, Instagram, and YouTube has been shown to have a negative impact on the cognitive abilities of Generation Z, specifically on their attention, memory, and problem-solving skills. Watching short videos in particular can weaken their critical thinking and problem-solving skills (Sureshkumar, 2025).

As already indicated, one consequence of this constant digital engagement for the young generation is that their thought processes differ from those of previous, older generations. It should also be emphasized that these changes are not genetic in origin but result from growing up with continuous access to digital technologies. These shifts in thinking naturally also lead to specific learning preferences (Shirazian et al., 2025). One notable aspect of how Generation Z members process information is their inclination toward visual content — that is, information conveyed through videos, images, or infographics — which they prefer over text. This preference is also evident on platforms such as YouTube, Instagram, Snapchat, and TikTok, which likewise dominate their media consumption (Shaikh, 2024). According to Shirazian et al. (2025), this dominance of visual information processing is attributable to the region of the brain responsible for visual abilities and the processing of complex images, which is considerably more developed in Generation Z. As a result, visual forms of learning are more effective for them than traditional lecture-based instruction relying on listening, which they find less appealing (Shirazian et al., 2025). The digital engagement of Generation Z members exposes them to constant access to large volumes of information. While this can lead to information overload, in the context of education and learning it can also be understood as a certain independence or self-sufficiency of young people in seeking answers to their questions or solving various problems on their own (Shaikh, 2024). Since these young people are accustomed to obtaining information instantly through search engines, they often prefer to study at their own pace and may also employ so-called *"self-education"* or *"self-directed learning"* methods (Shirazian et al., 2025). Self-directed learning can be defined as a process in which an individual independently assesses their own learning needs, sets goals, and takes the initiative in finding ways to acquire new knowledge (KnowledgeAnywhere, n.d.). For self-directed learning to be effective, students must, according to scholars, possess a mature, outcome-oriented approach to learning — one that serves not merely to fulfill course requirements but also to develop their own knowledge and skills. At the same time, they must be able to manage their time effectively and reflect on their decisions. Effective self-directed learning also requires technological readiness. Students' perception of web-based learning technologies significantly influences their learning behavior, since students who can effectively access and utilize online materials and online learning tend to perform better, and still value personal interactions during which they can receive feedback (Geng et al., 2019). Nair et al. (2023) reach similar conclusions, finding that students learn more effectively in the presence of an instructor than through self-directed learning alone. However, they do not claim that self-directed learning is useless. Scholars emphasize that technology and self-directed learning show a positive association with student motivation, but that students still prefer guided, in-person, interactive learning involving an engaged teacher (Nair et al., 2023).

[1] The term *"media convergence"* refers to the gradual interlinking of different media and technologies. Thanks to modern technology, the same media content is now available through multiple channels. At the same time, the functions of devices that were once separate are also merging. Media convergence thus represents the merging of media, technologies, and their functions into a single system or device (Brestovanský, 2010).

2 Methodology

We decided to structure this paper as a systematic review. This approach represents a synthesis of knowledge that is identified and critically evaluated. The aim of systematically gathering and synthesizing scientific findings is to achieve a deeper understanding of a specific issue. At the same time, the systematic procedure adopted ensures that all relevant studies are included in the synthesis, while also reducing the risk of bias by establishing predetermined study-selection criteria prior to the search itself (Randles & Finnegan, 2023). Conducting a systematic literature review involves several steps, namely defining the research questions, establishing inclusion and exclusion criteria for scientific studies, carrying out a comprehensive review of the relevant scientific literature, analyzing and extracting the findings, and, finally, synthesizing and interpreting the results (Fain, 2025). The first phase of the systematic review primarily involves establishing the aim and research questions and collecting the scientific studies to be analyzed in the second, empirical phase of the work. In this first phase, we therefore followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which condition study selection on the establishment of exclusion and inclusion criteria used to select the relevant scientific papers. This is followed by a transparent description of the selection process, including the choice of search keywords and the scientific databases from which studies were drawn. The final step is the critical appraisal of the studies (Page et al., 2021). The second phase of the research consists of analyzing and synthesizing the findings from the selected studies. In this context, it should also be noted that for the analysis itself we adopted a qualitative research approach and, for this purpose, decided to apply so-called thematic synthesis. Thematic synthesis is used in qualitative research and serves to effectively combine the results of multiple studies, including within systematic reviews. The process of qualitative synthesis consists of three steps: coding the text, generating descriptive themes, and subsequently developing analytical themes. This research technique allows researchers to go beyond the original data and generate new hypotheses or concepts, while maintaining a transparent link to the primary sources (Thomas & Harden, 2008).

2.1 Defining the research problem, aim, and research questions

Based on the information presented above in the introduction, we can state that the close connection between Generation Z and digital technologies substantially shapes the way these young people learn and process information. This, in turn, gives rise to various specific characteristics and preferences in their educational process. One such preference is so-called self-directed learning. Today, however, artificial intelligence (AI) may also enter into this process, as it can be integrated into self-directed learning through personalized tools and real-time support (Vijnatham School, 2025). Artificial intelligence has the potential to substantially support this process, but on the other hand may also limit its effectiveness. The aim of this paper is to identify and synthesize the positive and negative aspects of AI use in the self-directed learning process of Generation Z members, with an emphasis on the mechanisms and conditions under which individual factors of AI use act as either enablers of, or barriers to, effective self-directed learning.

Research questions:

PRQ: What aspects of artificial intelligence (AI) use in the self-directed learning process of Generation Z members, in terms of their impact on the effectiveness of this type of learning, appear in the findings of the selected scientific publications?
SRQ1: What positive aspects, or supportive mechanisms, of AI tool use can be identified in scientific studies in the context of the self-directed learning of Generation Z members?
SRQ2: What negative aspects, or risks and barriers, do the selected scientific studies associate with the use of AI in the self-directed learning process of Generation Z members?

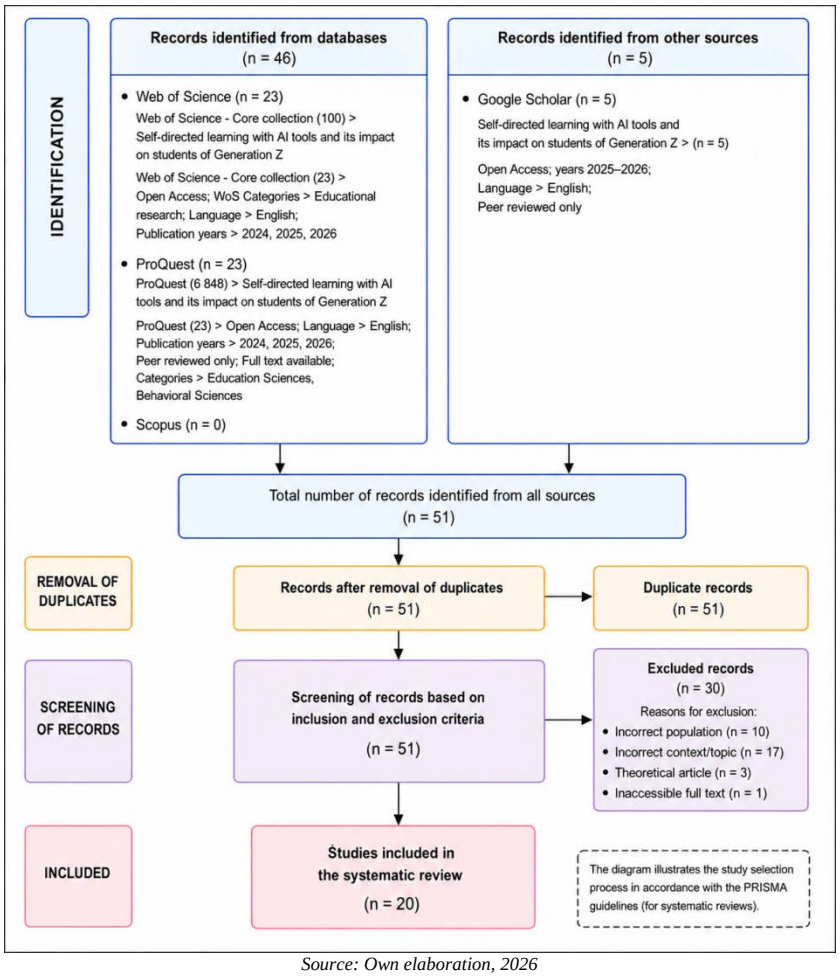
2.2 Study selection strategy for the systematic review

Three scientific databases were used to conduct the systematic review: Web of Science — Core Collection, Scopus, and ProQuest. The Google search engine was also used to search for studies. The search was carried out using a combination of keywords covering three conceptual areas: (1) Generation Z, (2) self-directed learning, and (3) artificial intelligence. All three areas were incorporated into a single English-language search phrase: *"Self-directed learning with AI tools and its impact on students of Generation Z."* The search was limited to studies published between 2024 and 2026, and covered study titles, abstracts, and keywords. The search results were then subjected to a screening process in accordance with predetermined inclusion and exclusion criteria, formulated in line with the systematic literature review methodology and the PRISMA 2020 statement (Page et al., 2021), and consistent with the established research questions and the chosen thematic synthesis method (Thomas & Harden, 2008).

Inclusion criteria: 1. Topic and content of the study: The systematic review included studies examining the use of artificial intelligence tools in self-directed learning, where the research population consisted of Generation Z members or university students. University students were included as an equivalent group, since the current university-age population overlaps substantially with Generation Z in terms of age, and not all authors explicitly identify this generational affiliation. 2. Type of publication: Included were empirical studies employing quantitative, qualitative, or mixed methods, review studies relevant to the topic, and conference papers indexed in WoS or Scopus. 3. Time frame: Studies published between 2024 and 2026 (given the pace of development of AI tools in education). 4. Language of publication: Primarily studies published in English or Slovak/Czech were included. 5. Availability: Studies included in the review had to be available in full text.

Exclusion criteria: 1. Topic and content of the study: In terms of topic and content, we excluded studies focused on other generational cohorts (Millennials, Generation X, Baby Boomers, Generation Alpha) without specific consideration of Generation Z, as well as studies addressing AI in education without a contextual link to students (e.g., the administrative use of AI in educational institutions, and similar topics). 2. Type of publication: Studies published without peer review were excluded from the systematic review. 3. Time frame: Studies published before 2024. 4. Language of publication: Studies published in languages other than English, Slovak, or Czech were excluded. 5. Availability and quality: Studies were also assessed and excluded on the basis of whether they were available in full text and had a clearly described methodology and research design. Duplicates were also removed from the systematic review using the Zotero application.

Figure 1: The diagram illustrates the process of identifying, screening, and including studies in the systematic review in accordance with the PRISMA 2020 statement.



Source: Own elaboration, 2026

Table 1: Overview of scientific studies included in the knowledge synthesis

Author	Aim of the study	Research sample	Study methodology
Jhoname Besas, Louida Patac & Adriano Patac Jr. (2026)	To examine the relationship between AI-supported self-directed learning (SDL) and performance in mathematics among Generation Z students.	Junior high school students, grades 7–10 (Generation Z) > purposive sample. n = 345	Mixed method (convergent design). 272 students in the quantitative part (questionnaire) and 73 in the qualitative part (focus groups).
Anastasiya Shikina (2025)	To determine how AI tools help Uzbek students develop self-directed learning skills and increase their autonomy and motivation.	Undergraduate and postgraduate students (Generation Z) > purposive/convenience sample n = 27	Quantitative method (questionnaire) supplemented by thematic analysis of semi-structured interviews.
Wanxin Yan, Taira Nakajima & Ryo Sawada (2024)	To examine students' perspectives, benefits and challenges of using generative AI as a learning partner in the process of learning programming.	Third-year undergraduate students (Generation Z) > purposive sample. n = 9	Qualitative method (case study).
Davy Tsz Kit Ng, Chee Wei Tan & Jac Ka Lok Leung (2023)	To evaluate the impact of GPT-driven chatbots on self-regulated learning (SRL) and science knowledge among students, compared with traditional chatbots.	Fourth-year high school students (Generation Z) > purposive/convenience sample. n = 74	Mixed method: quasi-experiment and follow-up interviews. (37 students in the experimental group and 37 in the control group)
Mohammed Ahmed Kofahi & Anas Jebreen Atyeh Husain (2025)	To present a ChatGPT-supported learning model and examine its effects on higher-order thinking (HOT) skills among IT students.	Undergraduate students in IT (Generation Z) > purposive sample. n = 53	Quantitative method (quasi-experimental design). Students were randomly divided into two groups (30 in the experimental and 23 in the control group).
Ke Wang & Zong Guo (2025)	To quantitatively synthesize existing evidence on the impact of generative AI on students' cognitive, behavioral and affective engagement.	The sample consisted of scientific studies covering various levels of education, including basic, higher and lifelong education. > systematic selection. n = 31 scientific studies	Quantitative method (meta-analysis).
Evangelia Manousou (2025)	To examine the development of perceptions and practices of fostering critical thinking in postgraduate distance education over the course of a	Students and graduates of postgraduate programs (higher education) focused on educational sciences and technology (Generation Z) > purposive sample. n =	Qualitative method (semi-structured interviews and thematic analysis).

	decade, with a focus on the role of AI.	30	
Jerry Chih-Yuan Sun, Hsueh-Er Tsai & Wai Ki Rebecca Cheng (2022)	To understand the effects of a personalized data-visualization platform on students' strategies and behavioral patterns in self-regulated learning.	Master's and doctoral students from four national universities (Generation Z) > purposive/convenience sample. n = 182	Quantitative method (four-group experiment and sequential analysis).
Ziwei Li, Chunlai Wang & Curtis J. Bonk (2024)	To examine students' motivations and strategies when using ChatGPT for self-directed online language learning.	Undergraduate students (Generation Z) > random and purposive sample. n = 287	Mixed method (questionnaire and interviews). 276 students completed the questionnaire and 11 took part in in-depth interviews.
Jasper Roe & Mike Perkins (2025)	To map the landscape of generative AI applications in the context of SDL and critically evaluate their benefits and risks based on existing evidence.	Studies drawn predominantly from the higher-education environment. Scientific studies were analyzed. > systematic selection. n = 18 scientific studies	Qualitative method (thematic scoping review).
Ali Darvishi, Hassan Khosravi, Shazia Sadiq, Dragan Gašević & George Siemens (2023)	To examine the effect of AI assistance on students' independence and initiative and to determine whether they can maintain the quality of their work after this support is removed.	Undergraduate students from ten different disciplines (Generation Z) > random sample. n = 1,625	Quantitative method (randomized controlled experiment).
Fernando Viadero-Monasterio et al. (2026)	To analyze the impact of integrating generative AI into an engineering course on students' autonomy and academic outcomes.	Engineering course students, university students (Generation Z). > purposive/convenience sample. n = 132	Quantitative method (grade analysis and questionnaire survey).
Kristina Posavec (2026)	To examine how students construct prompts and how this practice relates to their self-directed learning skills and AI literacy.	First-year female bachelor's students (Generation Z) > purposive sample. n = 57	Quantitative phase: provided descriptive findings on prior experience. Qualitative phase: captured the reflections of the female students.
Joel Weijia Lai et al. (2025)	To analyze students' interactions with a Socratic chatbot in a statistics course in order to gain insight into self-regulated learning processes.	Undergraduate students (Generation Z) > purposive sample. n = 34	Quantitative method (epistemic network analysis — ENA).
Sung-Hee Jin, Kowoon Im, Mina Yoo, Ido Roll & Kyoungwon Seo (2023)	To examine students' perceptions of AI applications supporting self-regulation and to identify important pedagogical and psychological aspects of their integration.	University students across ten different disciplines. > purposive sample. n = 16	Qualitative method (exploratory design using the "speed dating" method with storyboards).
Guixia Wang, Zehui Zhan & Shouyuan Qin (2025)	The aim of the study was to design and test an intelligent tutoring model (KG-CQ) that integrates knowledge graphs with LLMs to support self-directed learning.	University students in Educational Technology in China (Generation Z) > purposive sample. n = 30	Quantitative method (comparative model experiment).
Mehmet Yavuz, Şener Balat & Bünyami Kayalı (2025)	To determine the impact of an AI-supported flipped classroom on the literacy, perceptions and experiences of higher-education students.	First-year vocational higher-education students in Web Design and Coding (Generation Z) > purposive/convenience sample. n = 33	Mixed method (quasi-experimental pre-test/post-test design and qualitative case study).
Ahmed Kharrufa & Ian Johnson (2024)	To explore the possibilities and pedagogical implications of integrating generative AI into education in the field of human-computer interaction (HCI).	Third-year undergraduate computer science students (Generation Z) > purposive/convenience sample. n = 12	Qualitative method (pedagogical reflection and module delivery report).
Huiwen Zou et al. (2026)	To explore how pedagogical novelty and ethical awareness influence students' acceptance of AI, and whether ethics prevents the emergence of mindless dependence.	University computer science students (Generation Z) > purposive/convenience sample. n = 134	Quantitative method (quasi-experiment and SEM model analysis).
Madina Yermaganbetova et al. (2026)	To evaluate the effectiveness of an integrated AI platform in improving performance, motivation and self-directed learning in a 3D-modeling course.	Second-year undergraduate students. > purposive/convenience sample. n = 120	Mixed method (quasi-experiment with pre-test and post-test, and thematic analysis). 62 students participated in the experimental group and 58 in the control group.

Source: Own elaboration, 2026

3 Results

3.1 Coding and the development of descriptive themes

In this chapter, we present the individual thematic codes as well as the descriptive themes. The analysis and coding of the findings from the individual scientific studies included in the systematic review provided the basis for developing the descriptive themes. Through this process, using an inductive approach, we identified several codes that recurred across the results of the studies. These are, specifically: (1) personalized support and motivation, (2) availability and immediate feedback, (3) emotional well-being and stress relief, (4) support for metacognition, (5) risk of excessive reliance on or dependence on AI, (6) risk of passive learning, (7) cognitive offloading, (8) goal-setting and self-paced learning, (9) cognitive development / reduced cognitive load, (10) more effective time management, (11) inaccurate information and AI hallucinations, (12) technological/AI literacy, (13) AI as an aid rather than a replacement for the tutor/teacher, and (14) ethical dilemmas in the use of AI. In addition, we identified further codes that did not recur across the results of the studies and were therefore not included in the knowledge synthesis.

As already stated in the Methodology, the process of thematic synthesis consists of three steps: (1) coding the text, (2) developing descriptive themes, and (3) developing analytical themes, i.e., the synthesis of the findings itself. By sorting and grouping the individual codes into similar thematic clusters, we developed six descriptive themes: Theme 1: Personalized support — comprises the codes personalized support and motivation, availability and immediate feedback, and emotional well-being and stress relief. Theme 2: Support for cognitive development — draws on the codes support for metacognition and cognitive development/reduced cognitive load. Theme 3: Self-regulation of learning — is formed by the codes goal-setting and self-paced learning and more effective time management. Theme 4: Risk of passivity in AI use —comprises the codes risk of excessive reliance on or dependence on AI, risk of passive learning, and cognitive offloading. Theme 5: Limitations of AI tools in self-directed learning — links the codes inaccurate information and AI hallucinations and technological/AI literacy.

Theme 6: The relationship between AI and the human factor — consists of the codes AI as an aid rather than a replacement for the tutor/teacher and ethical dilemmas in the use of AI.

3.2 Thematic synthesis of findings and development of analytical themes

Based on the results of the systematic literature review, we proceeded to synthesize the findings, that is, to develop the analytical themes. This paper focuses on the aspects of artificial intelligence (AI) use in the process of self-directed learning among Generation Z members. The central aim, through a systematic review of relevant scientific publications and qualitative thematic synthesis, is to identify and synthesize the aspects of AI use that support young people in the self-directed learning process. A further aim is to identify the risk-related aspects that could act as barriers to self-directed learning within this generational cohort. Based on the thematic synthesis, analytical themes were established, through which the findings are interpreted in the following section in relation to the stated research questions:

SQ1: *What positive aspects, or supportive mechanisms, of AI tool use can be identified in scientific studies in the context of the self-directed learning of Generation Z members?*

3.2.1 Artificial intelligence as a safe and personalized tutor

In order to answer the first research question, the thematic synthesis of findings focused on the aspects of AI use that could have the potential to support the self-directed learning process among Generation Z members. The extracted findings show that the use of artificial intelligence (AI) in the self-directed learning process is of great significance to students, primarily as a form of support across various domains. Based on research conducted with students, scholars point out that AI becomes a kind of *"personal tutor"* for them. For example, the findings of Besas et al. (2026) indicate that the support provided by artificial intelligence lies primarily in the fact that, unlike teachers, it is available to students at all times, which allows them to maintain their learning momentum (Besas et al., 2026). Immediate and personalized feedback from AI in the self-directed learning process gives students the opportunity to solve various problems or have more complex topics explained to them right away, even outside of class (Besas et al., 2026; Shikina, 2025; Roe & Perkins, 2025). An interesting finding in this context is that students in the research group of the study by Kharrufa and Johnson (2024) reported using AI for its ability to sustain a dialogue and turn abstract definitions into real-world examples. This allowed them to better understand the problems they were working on (Kharrufa & Johnson, 2024). The high degree of personalization and availability of AI use within self-directed study also contributes to the formation of habits related to working on assignments and learning, which contributes to better time management (Li et al., 2024). These findings therefore also point to the use of artificial intelligence for the possibility of individualized, real-time support. In addition, students show a greater tendency toward interactive querying — that is, they reformulate their query or question multiple times until they sufficiently understand the topic. This is also a consequence of the sense of safety in the learning process, which is very important for Generation Z. This, in turn, leads to emotional well-being and reduced anxiety, since AI provides them with a judgment-free environment in which students are not ashamed to make mistakes (Besas et al., 2026). Students also benefit from the fact that AI tools transform the traditional learning environment, giving individuals greater control over their study process. They can set their own pace and approach to studying, or even generate their own study aids, which has a positive impact on their engagement (Shikina, 2025). Scholars nevertheless point out that the best outcomes were achieved by students who, within self-directed learning, used AI tools as a so-called *"scaffold."* In this context, this refers to students using AI alongside their own thinking — for example, to check the correctness of their reasoning or to understand a complex topic — rather than merely as a shortcut to ready-made generated results (Besas et al., 2026; Wang & Guo, 2025).

3.2.2 AI tools as support for the development of metacognition

Personalized AI support for students, however, need not serve only as a tutor; as already mentioned, it can also act as a *"mirror"* for understanding and identifying one's own knowledge gaps. This process is part of so-called *"metacognition."* [2] By being able to use a chatbot as an interactive partner, students can also improve their metacognitive ability within self-directed learning, which contributes to better outcomes. According to the findings of Kharrufa and Johnson (2024), students must actively work to formulate their prompts and queries with sufficient complexity. If a student enters a superficial or unclear prompt, the AI generates an equally superficial result. This direct feedback leads students to recognize the gaps in their own argumentation and understanding of context, which motivates them toward deeper reflection and the refinement of their own reasoning (Kharrufa & Johnson, 2024). Properly harnessed interaction with AI leads students to critically evaluate answers, explain problems, and effectively formulate their questions. As a result, they must adapt their communication strategies, which leads to greater awareness of their own cognitive processes (Yan et al., 2024; Besas et al., 2026). AI can also stimulate students' thinking by prompting them to reflect on their own strategies and progress. According to the findings of the study by Ng et al. (2024), specialized AI chatbots (SRLbots) encourage students toward metacognitive reflection by asking them questions about their learning goals, prior knowledge, and the success of the strategies they have chosen. This process helps students better track their progress and, when necessary, adapt their approaches in real time. A further example is the experimental study by Yermaganbetova et al. (2026), which used an AI-integrated platform. This platform served as the aforementioned *scaffold*, reinforcing strategic learning behavior and leading students toward active planning and self-correction in their learning and work process. The visualization of progress is also useful for students in this process. The AI-supported learning model tested in the study by Sun et al. (2023) gave students the ability to visualize data. Thanks to the ability to visualize personalized feedback, students were better able to identify their weaknesses and target their improvement efforts, which strengthens their metacognitive control over learning (Sun et al., 2023).

3.2.3 Artificial intelligence as a tool for stimulating cognitive and affective processes

The use of AI tools in self-directed learning can also contribute to the development of students' cognitive and affective components. The findings of the scientific studies suggest that, in terms of strengthening cognitive components, this primarily concerns deep information processing, problem-solving, and the analysis and evaluation of knowledge (Wang & Guo, 2025; Kofahi & Husain, 2025). Scholars, however, discuss this benefit in the context of using AI tools as targeted, personalized support in the learning process — that is, as the aforementioned *"scaffold"* — rather than as a tool that generates ready-made outputs. A confirming example is the experimental study by Yavuz et al. (2025), in which the researchers used a *"flipped classroom"* [3]model incorporating artificial intelligence. According to the findings, the use of AI tools within this model strengthened students' critical thinking and problem-solving skills while also increasing their AI literacy (Yavuz et al., 2025). The use of AI tools in the self-directed learning process can also have a positive effect on students' affective, i.e., emotional, experience during learning. The previously mentioned personalized and immediate AI feedback has the potential to

[2] The term *"metacognition"* refers to complex thinking that enables one to understand, analyze, and control one's own cognitive processes, especially when learning (Cambridge Dictionary, n.d.).

[3] The *"flipped classroom"* model refers to a teaching method where students are exposed to information before instruction, freeing up time within the lesson for activities that involve "higher-order thinking," that is, thinking at a higher cognitive level (Harvard Bok Center, n.d.).

alleviate the anxiety, boredom, and frustration that students may experience during conventional instruction as passive recipients of information (Wang & Guo, 2025; Kofahi & Husain, 2025). At the same time, the interactive mode of querying can stimulate curiosity and interest in students (Wang & Guo, 2025).

SQ2: *What negative aspects, or risks and barriers, do the selected scientific studies associate with the use of AI in the self-directed learning process of Generation Z members?*

3.2.4 Risk of cognitive passivity and excessive reliance on AI

In the preceding subsections, we outlined the various mechanisms that have a positive effect on the self-directed learning process of Generation Z members. These aspects of AI tool use were frequently explained by scholars in relation to the concept of the *"scaffold,"* which is key to the transition to the analytical themes addressing the second research question, focused on the risks and barriers of AI use in the self-directed learning process of young people. The results of the studies indicate that one of the risk factors of AI use within self-directed learning may be excessive reliance on, or even dependence on, artificial intelligence. This can lead to the superficial acceptance of information and ready-made answers without critical reflection. This means that students would not engage themselves, for example, in analyzing data or text, but would instead leave this to AI. The consequence of such dependence is a reduced capacity for independent problem-solving and critical thinking, and it may also lead to *"rigid cognitive patterns"* [4](Besas et al., 2026; Wang & Guo, 2025; Manousou, 2025). If a student accepts only ready-made solutions, they stop "exercising their brain," which leads to growing ignorance and an inability to independently assess the truthfulness of information, or even to stagnation and decline in creative thinking and imagination (Manousou, 2025). If students rely too heavily on AI outputs without deeper understanding, there is also a risk of superficial learning without genuine comprehension, or even plagiarism in school or academic assignments (Yan et al., 2024). Interesting findings in this context were produced by the experimental study of Darvishi et al. (2024). The scholars found that when AI support was removed, the quality of students' work dropped sharply, suggesting that they had not actually acquired the knowledge but had merely *"outsourced"* it — literally meaning the delegation of certain tasks, in this case to an AI tool. This risk factor is directly related to the concept of *"cognitive offloading"* (Darvishi et al., 2024). Students' tendency toward this cognitive offloading is problematic primarily because they may shift key problem-solving steps or logical reasoning onto AI that they would otherwise have to carry out themselves. This process leads to a reduction in deep cognitive processing of information, which in turn weakens the long-term retention of knowledge in memory. At the same time, cognitive offloading can turn the process of learning, acquiring knowledge, and building genuine understanding into mere mechanical task completion (Besas et al., 2026). Drawing a comparison of the findings discussed so far, we can conclude that the risk of cognitive passivity is not caused by the technology itself but by its uncritical and passive use. It is therefore essential, when using AI tools in the self-directed learning process, to use them as a *"scaffold,"* that is, as a form of support that allows students to ask questions while still thinking about the context, critically evaluating their reasoning, and understanding problems — rather than merely passively generating answers.

3.2.5 Limitations of AI tools in the self-directed learning process

Within the process of AI-assisted self-directed learning, there are various limitations inherent to the tools themselves. According to the findings of the scientific studies, these errors are not merely a technical imperfection; they can affect the quality of education and students' critical thinking. Based on the results of the thematic synthesis, the most significant limitation of artificial intelligence is its tendency to provide incorrect, incomplete, or outdated information. This results from the fact that large language models (such as ChatGPT) may misinterpret the context of a question or prompt and therefore generate factually incorrect responses, or even *"hallucinate."* [5](Wang et al., 2025). Researchers Viadero-Monasterio et al. (2026) also point out that students sometimes fail to realize that the hallucinations generated by artificial intelligence are often not immediately obvious and can easily be overlooked. The results of the study also show that while 50% of students were able to recognize incorrect information, only 18% of them regularly checked external sources to verify the accuracy of the answers. At the same time, the quality of responses depends heavily on how the prompt is formulated, with imprecisely worded questions leading to vague or irrelevant answers (Viadero-Monasterio et al., 2026). Students often lack sufficient skills to use AI tools correctly, which leads to frustration (Shikina, 2025). A teaching model based on the flipped classroom could have the potential to reduce these risks. This is demonstrated by the experimental study of Yavuz et al. (2025), in which students engaged with the learning materials at home and used AI tools in the classroom. This approach helped improve the overall level of AI literacy among the students who took part in the experiment (Yavuz et al., 2025). We can therefore say that the use of AI tools proved effective in improving AI literacy when practically applied within the teaching process in the presence of educators. These findings are further supported by those of a study focused on the use of AI tools for self-directed language learning within informal education. Based on the results, the scholars concluded that although AI is a useful technological tool, it is not, on its own, the only factor in self-directed learning. It can effectively serve as a facilitator and supplement, but AI cannot be regarded as a full substitute for the process of self-directed learning, or for the internal cognitive work an individual must invest in order to acquire knowledge or skills. The researchers also recommend incorporating AI into a broader ecosystem of educational tools, since it offers a high degree of personalization and flexibility, but in the context of self-directed learning it works best as a supplementary resource strategically linked with other established methods and tools (Li et al., 2024).

3.2.6 Ethical dilemmas in the use of AI tools

The final analytical theme extracted from the thematic synthesis of findings concerns the ethical dilemmas related to the use of artificial intelligence tools in the self-directed learning of the younger generation. In this context, scholars point in particular to the dilemma of where the boundaries of a student's authorship lie when using AI. According to Posavec (2026), students are often unsure how to balance the contribution of artificial intelligence with their own authorship. This raises questions about personal responsibility and academic integrity (Posavec, 2026). Another problematic aspect of ethics in the use of AI tools, according to Zou et al. (2026), is the student's own approach — that is, whether they use these tools "mindlessly" or as a supplement to conscious reasoning. Within the learning process, a tension arises between fast, automated behavior and the need for deep reflection. According to the study's findings, ethical awareness functions as a *"cognitive brake"* that forces students to step out of automated mode and switch into conscious, analytical reasoning. According to the author, however, the very nature and speed of the technology tempts students toward mindless dependence, which the student must consciously guard against in order to preserve their intellectual autonomy (Zou et al., 2026). The final ethical dilemma emerging from the thematic synthesis of findings and the selected studies is algorithmic bias. Wang and Guo (2025) note that the use of artificial intelligence carries an ethical risk associated with algorithmic bias and data inaccuracies. If students merely

[4] The term *"cognitive rigidity"* can be understood literally as *"cognitive inflexibility."* Cognitive rigidity refers to difficulty adapting one's thinking or behavior in response to new information, challenges, or perspectives. This mental inflexibility can limit one's ability to solve problems, connect with others, and thrive in changing environments (My LA Therapy, 2025).

[5] *"Hallucinations"* in generated content are when AI tools create incorrect, misleading, or nonexistent content. The content can include facts, source citations, code, historical events, and other real-world information (University Library – LibGuides, 2026).

passively accept outputs without critical reflection, they risk internalizing such distorted information without realizing it, which undermines the ethical dimension of self-directed learning (Wang & Guo, 2025). A sufficient level of ethical awareness helps students clearly define the boundaries of acceptable AI use, thereby reducing perceived risk and strengthening their conscious intent to use the tool responsibly (Zou et al., 2026).

3.3 Synthesis of findings in relation to the main research question

The main research question seeks to answer what aspects of artificial intelligence use in the self-directed learning process of Generation Z, in terms of their impact on the effectiveness of this type of learning, appear in the findings of the studies included in the systematic review. Based on the thematic synthesis, we can say that scholars have identified, through their research, various aspects of AI tool use that can function as support for students within the self-directed learning process. AI can serve as a safe and personalized tutor, since it does not provoke anxiety, fear, or frustration in students. According to the findings, AI tools also support the process of metacognition. Properly harnessed interaction with a chatbot can help students develop metacognition through improving their ability to write clear prompts, receiving feedback, or even through the ability to visualize their progress in graphs. AI tools also have the potential to develop both the cognitive and affective aspects of individuals. Across all of these aspects, it is crucial that students can make the best use of these supportive features of AI tools only under the condition that they use them as support, or as a *"scaffold,"* rather than solely to generate ready-made answers without critical reflection. Researchers also point to risk-related aspects of AI tool use. The results of the thematic synthesis show that the main risk of AI use in the self-directed learning process of Generation Z is excessive reliance on its outputs, which can lead to cognitive passivity, weakened critical thinking, reduced creativity, and a diminished ability to solve problems independently. Passively accepting answers promotes superficial learning, reduces long-term retention of knowledge, and increases the risk of plagiarism. One limitation of AI use is also the risk of generating inaccurate, incomplete, or outdated information, which students often fail to sufficiently verify, and the quality of the answers depends on the ability to formulate appropriate prompts. Other risk-related aspects include insufficient AI literacy, which can lead to frustration and the ineffective use of the tools. Within the thematic synthesis, we also identified ethical dilemmas. These relate to the boundaries of authorship, academic integrity, and algorithmic bias.

4 Conclusion

The aim of this paper was to identify and synthesize the positive and negative aspects of using artificial intelligence in the self-directed learning processes of Generation Z through a systematic literature review conducted in accordance with the PRISMA framework and a qualitative thematic synthesis following Thomas and Harden (2008). Based on the analysis of selected scholarly studies, it can be stated that artificial intelligence holds supportive potential for self-directed learning. AI can serve as a personalized and safe source of feedback, foster the development of metacognition, and positively influence students' cognitive and affective experiences during learning. However, this potential is realized most effectively when students approach AI as a tool that supports their own thinking rather than as a means of replacing their cognitive work. At this juncture, the positive and negative aspects of AI use converge — the same feature of AI, namely real-time availability that promotes learning, may, when used uncritically, become a source of cognitive passivity, superficial learning, or even plagiarism. The findings of the thematic synthesis also point to limits of the technology itself as well as limits of users, along with ethical concerns related to authorship boundaries and algorithmic bias. From this follows that the effectiveness of AI-supported self-directed learning among young people is not determined by the technology alone but by the degree of critical reflection with which students employ it. The present systematic review has its own limitations. The included studies differ methodologically (quantitative, qualitative, and mixed-methods designs) and in sample size, which restricts the generalizability of the synthesized findings. The review was also limited to studies published in English, Slovak, and Czech and to the period 2024–2026, which may have unintentionally excluded relevant older or linguistically different scholarly sources.

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Primary Paper Section: A

Secondary Paper Section: AM