

Varazdin Development and Entrepreneurship Agency and
GOVCOPP - University of Aveiro, Portugal

In cooperation with:

Faculty of Management University of Warsaw, Poland
Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat, Morocco
Ecole Nationale de Commerce et de Gestion de Tanger - Abdelmalek Essaadi University, Morocco
Medimurje University of Applied Sciences in Cakovec, Croatia



Book of Proceedings

132nd esd Aveiro 2026

Digital & Sustainable Financial Literacy for Inclusive Social Development: Challenges, Innovations & Impact

Editors:

Humberto Ribeiro, David Nunes Resende, Mislav Ante Omazic



ISBN 978-953-6125-41-8



9 789536 125418 >

February, 2026

**Varazdin Development and Entrepreneurship Agency and
GOVCOPP - University of Aveiro, Portugal**

In cooperation with:

Faculty of Management University of Warsaw, Poland

Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat, Morocco

Ecole Nationale de Commerce et de Gestion de Tanger - Abdelmalek Essaadi University, Morocco

Medimurje University of Applied Sciences in Cakovec, Croatia

Book of Proceedings

132nd esd Aveiro 2026

Digital & Sustainable Financial Literacy for Inclusive Social Development: Challenges, Innovations & Impact

Editors:

Humberto Ribeiro, University of Aveiro, Portugal

David Nunes Resende, University of Aveiro, Portugal

Mislav Ante Omazic, University of Zagreb, Croatia & IEDC – Bled School of Management, Slovenia

February, 2026

Title ■ Digital & Sustainable Financial Literacy for Inclusive Social Development: Challenges, Innovations & Impact - (Book of Proceedings)

Editors ■ Humberto Ribeiro, David Nunes Resende, Mislav Ante Omazic

Scientific Committee / Programski Odbor ■ Humberto Nuno Rito Ribeiro (President), University of Aveiro, Portugal; Sandra Raquel Alves, Polytechnic Institute of Leiria, Portugal; Zoltan Baracskaï, Szechenyi Istvan University of Győr, Hungary; Rado Bohinc, University of Ljubljana, Slovenia; Sonia Boushaba, Mohammed V University in Rabat, Morocco; Marijan Brubnjak, Student Centre Rijeka, Croatia; Domenico Bucella, Kozminski University, Poland; Ivan Burazin, Dr. Franjo Tuđman Defence and Security University, Croatia; Mirela Cristea, University of Craiova, Romania; Nedo Danilovic, MB University, Serbia; Darko Dukic, University of Osijek, Croatia; Gordana Dukic, University of Osijek, Croatia; Davor Filipovic, University of Zagreb, Croatia; Fran Galetic, University of Zagreb, Croatia; Matjaz Gams, Jozef Stefan Institute, Slovenia; Mirjana Gligoric Matic, University of Belgrade, Serbia; Luka Grbic, University of Zadar, Croatia; Alexandra Grobelna, Gdynia Maritime University, Poland; Anica Hunjet, University North, Croatia; Barbara Huszar, Szechenyi Istvan University of Győr, Hungary; Marcelo J. Meirino, Fluminense Federal University, Brazil; Gorm Jacobsen, University of Agder, Norway; Jelena Janjusevic, Heriot-Watt University, UAE; Irena Jankovic, University of Belgrade, Serbia; William J. Jones, Mahidol University International College, Thailand; Marina Klacmer Calopa, University of Zagreb, Croatia; Igor Klopotan, Medimurje University of Applied Sciences in Cakovec, Croatia; Mario Konecki, University of Zagreb, Croatia; Mladen Konecki, University of Zagreb, Croatia; Irena Konecki, University of Zagreb, Croatia; Ewa Koziem, Krakow University of Economics, Poland; Marek Koziem, Cracow University of Technology, Poland; Adam Koziem, Jagiellonian University in Krakow, Poland; Goran Kozina, University North, Croatia; Dzenan Kulovic, University of Zenica, Bosnia and Herzegovina; Abey Kuruvilla, University of Wisconsin-Parkside, USA; Ana Lorga, Lusofona University, Portugal; Mustapha Machrafi, Mohammed V University in Rabat, Morocco; Ahmed Maghni, ENCGT - Ecole Nationale de Commerce et de Gestion de Tanger, Morocco; Moulay Sadik Maliki, University of Hassan II Casablanca, Morocco; Candida Manuel Duarte, Lusofona University, Portugal; Mihaela Mikic, University of Zagreb, Croatia; Ivana Martinovic, University North, Croatia; Petar Misevic, University North, Croatia; Abdelhamid Nechad, ESCA - Ecole de Management, Morocco; Gratiela Georgiana Noja, West University of Timisoara, Romania; Brian O'Hara, Metropolitan State University of Denver, USA; Arpad Ferenc Papp-Vary, Budapest University of Economics and Business, Hungary; Dusko Pavlovic, Libertas International University, Croatia; Ivan Peronja, University of Split, Croatia; Igor Pihir, University of Zagreb, Croatia; Dinko Primorac, University North, Croatia; Miroslaw Przygoda, University of Warsaw, Poland; Karlis Purmalis, University of Latvia, Latvia; Nicholas Recker, Metropolitan State University of Denver, USA; Dusan Regodic, MB University, Serbia; David Resende, University of Aveiro, Portugal; Douglas Rhein, Mahidol University International College, Thailand; Maria Rosario Anjos, Lusofona University, Portugal; Robert Rybnicek, University of Graz, Austria; Peter Sika, University of Economics in Bratislava, Slovakia; Vesna Sesar, University North, Croatia; Martina Sopta, University of Zagreb, Croatia; Joanna Stawska, University of Lodz, Poland; Tomasz Studzieniecki, Academia Europa Nostra, Poland; Toni Susak, University of Split, Croatia; Sime Vucetic, University of Zadar, Croatia; Luka Vukic, University of Split, Croatia; Andrey Zahariev, The D.A. Tsenov Academy of Economics, Bulgaria; Snezana Zivkovic, University of Nis, Serbia.

Review Committee / Recenzentski Odbor ■ Marina Klacmer Calopa (President); Ana Aleksic; Mariza Almeida; Jorge Alves; Ayuba Aminu; Marlene Paula Castro Amorim; Mihovil Andjelinovic; Josip Arneric; Lidija Bagaric; Tomislav Bakovic; Adelina Baptista; Sanja Blazevic; Leonid Bobrov; Ruzica Breccic; Sonja Brlecic Valcic; Anita Ceh Casni; Iryna Chernysh; Angelo Maia Cister; Antonio Augusto Costa; Marco Andre da Silva Costa; Mirela Cristea; Oguz Demir; Marta Alexandra da Costa Ferreira Dias; Joana Maria Costa Martins das Dores; Stjepan Dvorski; Robert Fabac; Ivica Filipovic; Maria Alexandra Soares Fontes; Sinisa Franjic; Henrique Formigoni; Fran Galetic; Mirjana Gligoric; Tomislav Globan; Anita Goltnik Urnaut; Maria Jose Angelico Goncalves; Tomislav Herceg; Irena Jankovic; Emina Jerkovic; Dafna Kariv; Oliver Kesar; Hilal Yildirim Keser; Martina Dragija Kostic; Tatjana Kovac; Vladimir Kovsca; Eduardo Manuel de Almeida Leite; Jose Carlos Lopes; Vladimir Fernandes Maciel; Mara Teresa da Silva Madaleno; Katarina Marosevic; Vaidotas Matutis; Marcelo Jasmim Meirino; Joao Jose Lourenco Marques; Marjana Merkac Skok; Daniel Francois Meyer; Natanya Meyer; Josip Mikulic; Ljubica Milanovic Glavan; Raquel Filipa do Amaral Chambre de Meneses Soares Bastos Moutinho; Guenter Mueller; Ivana Nacinovic Braje; Zlatko Nedelko; Gratiela Georgiana Noja; Zsuzsanna Novak; Alcina Maria de Almeida Rodrigues Nunes; Alka Obadic; Claudia Ogorean; Jose Manuel Teixeira Pereira; Igor Pihir; Sandra Raquel Pinto Alves; Najla Podrug; Vojko Potocan; Dinko Primorac; Zeljka Primorac; Augusto Rapp; Nuno Manuel Rosa Dos Reis; David Nunes Resende; Sanda Renko; Humberto Nuno Rito Ribeiro; Vlasta Roska; Souhaila Said; Ana Paula Martins da Silva; Armando Javier Sanchez Diaz; Joao Carvalho Santos; Tomislav Sekur; Ana Lorga da Silva; Branca Santos de Silva; Amelia Cristina Ferreira da Silva; Lorena Skufflic; Mirko Smoljic; Petar Soric; Mario Spremic; Matjaz Stor; Tomasz Studzieniecki; Sandrina Francisca Teixeira; Lejla Tijanic; Daniel Tomic; Boris Tusek; Magda Sofia Valerio Monteiro; Rebeka Daniela Vlahov; Ilko Vrankic; Thomas Will; Zoran Wittine; Tao Zeng; Grzegorz Zimon; Snezana Zivkovic; Berislav Zmuk.

Organizing Committee / Organizacijski Odbor ■ Domagoj Cingula (President); Djani Bunja; Marina Klacmer Calopa; Spomenko Kesina; Erlino Koscak; Ivana Miklosevic; Tomasz Ochowski; Miroslaw Przygoda; Sandra Raquel Pinto Alves; Michael Stefulj; Rebeka Danijela Vlahov; Sime Vucetic; Marlene Paula Castro Amorim; Maria Cristina Goncalves Guardado; Mara Teresa da Silva Madaleno; David Nunes Resende; Marco Andre da Silva Costa; Marta Alexandra da Costa Ferreira Dias; Daniel Margaca Magueta; Joao Jose Lourenco Marques; Ana Lorga Silva; Catia Rosario; Magda Sofia Valerio Monteiro.

Publishing Editor ■ Domagoj Cingula

Publisher ■ Design ■ Varazdin Development and Entrepreneurship Agency / GOVCOPP - University of Aveiro, Portugal / Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat, Morocco / Ecole Nationale de Commerce et de Gestion de Tanger - Abdelmalek Essaadi University, Morocco / Medimurje University of Applied Sciences in Cakovec, Croatia.

Printing ■ Online Edition

ISBN 978-953-6125-41-8

The Book is open access and double-blind peer reviewed.

Our Books are available for download in a PDF format from the Economic and Social Development Conference website: <http://www.esd-conference.com>

© 2026 Published by: Varazdin Development and Entrepreneurship Agency / GOVCOPP - University of Aveiro, Portugal / Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat, Morocco / Ecole Nationale de Commerce et de Gestion de Tanger - Abdelmalek Essaadi University, Morocco / Medimurje University of Applied Sciences in Cakovec, Croatia.

All rights reserved. Authors are responsible for the linguistic and technical accuracy of their contributions. Authors keep their copyrights for further publishing.

CONTENTS

INDUSTRY 4.0 AND HUMAN-CENTRIC STUDIES: TRENDS IN PORTUGAL AND FRANCE

Cristina Rodrigues Piazer, Bruno Pedroso, David Nunes Resende, Claudia Tania Picinin..... 1

TECHNOLOGICAL ORIENTATION AS A DRIVER OF CONVENTIONAL AND ECO-INNOVATIONS IN HOSPITALITY: A CONCEPTUAL FRAMEWORK

Jasmina Sladoljev, Dijana Mecev, Franka Sladoljev 11

CHALLENGES OF THE MODERN WORLD AND THEIR IMPACTS ON MENTAL HEALTH IN THE EDUCATIONAL FIELD

Milena Borges Parente Thomazi, Claudia Tania Picinin, Guilherme Moreira Caetano Pinto, Vitor Hugo dos Santos Filho, David Nunes Resende 19

FROM OVEREXPOSURE TO EXCLUSION: RETHINKING DIGITALISATION THROUGH AN INTERGENERATIONAL KNOWLEDGE MANAGEMENT LENS

Andrea Lelovics 30

ENHANCING DIGITAL MATURITY IN CROATIAN HIGHER EDUCATION: RECOMMENDATIONS BASED ON EUROPEAN BEST PRACTICES

Dana Dobric Jambrovic..... 38

DIGITAL SCARCITY APPEALS IN TOURISM PLATFORMS: A DOUBLE-EDGED SWORD FOR CIRCULAR TOURISM CONSUMPTION

Erisa Mancellari, Gentjan Cera, Shpresim Domi..... 49

AI AND COMMUNICATION LITERACY IN JOURNALISM AND PUBLIC RELATIONS

Zlatko Vidackovic..... 57

REMOVAL OF A MEMBER OF THE MANAGEMENT BOARD (DIRECTOR) OF A LIMITED LIABILITY COMPANY: STATUS-RELATED LEGAL ASPECTS AND METHODS OF INTERPRETATION

Ratko Brnabic, Zaklina Harasic 66

USE OF AI METHODS IN STATISTICAL ANALYSIS, WITH SPECIAL FOCUS ON SERVICES

Iris Mihajlovic, Dorotea Markasovic, Lukrecia Draskovic 82

THE MEDITERRANEAN YACHT CHARTER MARKET IN A CONTEMPORARY CONTEXT: A QUANTITATIVE ANALYSIS OF SUPPLY, PRICES, AND FLEET UTILIZATION

Daniela Gracan, Marina Barkidija Sotosek, Ani Trstenjak **Error! Bookmark not defined.**

LABOUR MARKET TIGHTNESS AND SHIFTS IN THE BEVERIDGE CURVE IN THE EUROPEAN UNION FROM 2016 TO 2024

Sofija Turjak 101

ORGANIZATIONAL ADOPTION OF CAATTS IN INTERNAL AUDITING: A FACTOR IN STRENGTHENING RESILIENCE IN ENVIRONMENTAL TURBULENCE

Katarina Topolko Herceg 111

FINANCIAL INDICATORS AND AVERAGE NET WAGES IN SELECTED INDUSTRIES OF THE CROATIAN ECONOMY

Maja Buljat, Covic Kristijan, Doris Romc 121

LITERACY AND EDUCATIONAL CONSTRAINTS IN THE LABOR-MARKET INCLUSION OF MARGINALIZED ROMA IN SLOVAKIA

Tomas Sarkozi 131

DIGITAL TRANSFORMATION OF CULTURAL CONTENT: MUSEUMS BETWEEN ALGORITHMICALLY MEDIATED PLATFORMS AND IMMERSIVE TECHNOLOGIES

Hrvoje Mesic, Filip Kranjcevic, Vigor Marosevac 137

BETWEEN PRESCRIPTION AND REALITY: INSTITUTIONAL BARRIERS TO CORPORATE GOVERNANCE IMPLEMENTATION IN POST-TRANSITION SMES

Ivana Kovac, Zlatko Zuro 151

INDUSTRY 4.0 AND HUMAN-CENTRIC STUDIES: TRENDS IN PORTUGAL AND FRANCE

Cristina Rodrigues Piazer

*Graduate Program in Production Engineering –
Federal University of Technology – Paraná (UTFPR)
Ponta Grossa/PR, Brazil.
piazercristina@gmail.com*

Bruno Pedroso

*Full Professor at the Graduate Program in Health Sciences
Health Sciences Department
State University of Ponta Grossa, Paraná
Ponta Grossa/PR, Brazil
prof.brunopedroso@gmail.com*

David Nunes Resende

*University of Aveiro (Portugal), Researcher at GOVCOPP Research Unit – Governance,
Competitiveness and Public Policy CIS-GOVCOPP, Portugal
Aveiro, Portugal
david@ua.pt*

Claudia Tania Picinin

*Federal University of Technology – Paraná (Brazil); University of Aveiro (Portugal),
Researcher at GOVCOPP Research Unit – Governance, Competitiveness and Public Policy
CIS-GOVCOPP (Portugal).
Ponta Grossa/PR, Brazil
claudiapicinin@utfpr.edu.br*

ABSTRACT

Thus, the main objective of this study is to compare Portugal and France to identify prevailing trends, structural gaps, and strategic directions in the education and development of professional competencies within the context of Industry 4.0. A systematic literature review was conducted using the Scopus database, including the definition of country-specific search strings, the application of inclusion and exclusion criteria, and the performance of bibliometric and qualitative analyses. The final corpus comprised 18 articles on the Portuguese context and 80 on the French context, analyzed using the Bibliometrix package in RStudio. The results indicate a significant growth in scientific production on Industry 4.0 skills in both countries, particularly since 2016. Results point that in Portugal, the literature is mainly focused on organizational transformation, competitiveness, and professional education, with an emphasis on technical and managerial skills. In contrast, French scientific production presents a broader, more consolidated thematic structure, with a strong focus on artificial intelligence, data-driven systems, and the integration of technological and human-centered approaches. The discussion shows that these differences reflect distinct levels of scientific maturity and national innovation strategies, as well as specific priorities in skills development models. The study concludes that comparative analyses provide valuable contributions for policymakers, educational institutions, and organizations by supporting the design of more aligned and future-oriented strategies for skills development in the context of Industry 4.0.

Keywords: *Industry 4.0; Skills; Competencies; Bibliometric analysis; Portugal; France*

1. INTRODUCTION

The so-called Fourth Industrial Revolution, also known as Industry 4.0, has been driven by emerging technologies such as the Internet of Things (IoT), Big Data, artificial intelligence, cyber-physical systems, advanced robotics, and additive manufacturing. These technologies have promoted profound transformations in production systems by enabling real-time data processing, automation, and system integration, thereby redefining industrial operations and organizational structures ([1]; [2]). This transformation not only reconfigures production processes but also reshapes the role of workers, requiring new technical, digital, cognitive, and socio-emotional competencies to operate effectively in increasingly complex and interconnected environments ([3]; (Leng, 2021)). In this dynamic context, professional competencies must be continuously reassessed, as labor market requirements evolve rapidly in line with technological advances. Industry 4.0 constitutes a paradigm characterized by intensive digitalization, horizontal and vertical system integration, and data-driven decision-making. This scenario increases the demand for professionals with hybrid competency sets that combine advanced technical knowledge with analytical capabilities, adaptability, and socio-emotional skills. According to [5], the integration of technical, methodological, social, and personal competencies is essential for effective performance in smart manufacturing environments. Complementarily, [6] and [7] argue that the balance between hard skills such as automation, programming, and data analytics and soft skills such as communication, teamwork, leadership, and flexibility constitutes a determining factor for adaptability and resilience in Industry 4.0 contexts. Beyond operational efficiency, the literature highlights that Industry 4.0 profoundly affects work organization, learning processes, and workers' well-being. The automation of routine and physically demanding tasks shifts human work toward activities of a strategic, cognitive, and creative nature, intensifying the relevance of continuous learning and lifelong competency development ([Cimini, 2021]; [5]). At the same time, the digital transformation introduces psychosocial challenges related to work intensification, adaptability, and human-machine interaction, reinforcing the importance of socio-emotional competencies and quality of life oriented management practices in technologically intensive environments ([9]; [10]).

From an organizational and systemic perspective, innovation is a central element of Industry 4.0, supported by competencies in creativity, problem-solving, collaboration, and knowledge management [11]. This emphasizes that innovation in digitalized industrial environments depends not only on technological infrastructure but also on human and organizational capabilities that foster learning and interaction. Indicators such as innovative performance and patent development are directly related to the qualification of human capital and to the strategic alignment of competencies [12]. Competencies in innovation, worker well-being, and sustainability are becoming increasingly relevant for ensuring long-term competitiveness and organizational resilience ([13]; [14]). Educational systems and training institutions play a strategic role in aligning workforce qualifications with Industry 4.0 requirements. Persistent gaps between academic curricula and industrial needs underscore the urgency of curricular redesign, the adoption of interdisciplinary approaches, and the strengthening of cooperation between universities and companies ([15]; [16]). Studies focusing on the Portuguese context reveal that, while technical competencies are widely recognized as important, significant gaps remain in domains such as information technology, innovation, and inter-agency interaction ([7]). These findings reinforce the need for comparative analyses that account for diverse national trajectories and institutional arrangements. In this direction, comparative studies across countries offer valuable insights into how distinct educational systems, industrial policies, and innovation ecosystems respond to the challenges posed by Industry 4.0. Portugal and France present different yet complementary trajectories regarding digital transformation, workforce training, and industrial competitiveness within the European context.

Thus, the main objective of this study is to compare Portugal and France to identify prevailing trends, structural gaps, and strategic directions in the education and development of professional competencies within the context of Industry 4.0.

2. MATERIALS AND METHODS

This study adopted a systematic literature review as its methodological approach in order to identify and compare the professional skills required in the context of Industry 4.0 in Portugal and France. The review was conducted using the Scopus database, chosen for its broad coverage and the academic quality of the journals it indexes. The research process involved three main steps. First, specific keyword combinations related to Industry 4.0 and professional skills were defined for each national context. Second, the retrieved documents were filtered and organized according to predefined inclusion and exclusion criteria, ensuring that only relevant journal and review articles were considered. Third, the selected studies were subjected to bibliometric and qualitative analyses to support a structured comparison between the two countries. The data collection and analysis procedures were conducted independently for Portugal and France to respect the specificities of each context. All selected documents were exported from Scopus in CSV format and analyzed using appropriate bibliometric tools. This methodological design ensured consistency, transparency, and rigor in the analysis of Industry 4.0 skill demands across both countries.

2.1. Definition of Keyword

The combinations of keywords were designed to reflect the scope of each national context. In the case of Portugal, the search string was “Fourth Industrial Revolution” OR “Industry 4.0” AND “Skill*” OR “Competenc*” AND “Portugal”. For France, the search string was “Fourth Industrial Revolution” OR “Industry 4.0” OR “Smart Manufacturing” OR “Cyber-Physical System*” OR “CPS” OR “Cloud Manufacturing” OR “CM” OR “Big Data” OR “Big Data Analytics*” OR “Internet of Things*” OR “IoT” OR “Artificial Intelligence” AND “competence*” OR “skill*” AND “France*”. These keywords ensured the selection of studies addressing the relationship between Industry 4.0 and the skills required in each national context.

2.2. Filtering and Categorization

The documents were filtered based on titles and, when necessary, abstracts, to exclude publications not related to the research topic. Only journal articles and review articles were included, while conference proceedings were excluded. The final corpus comprised 18 articles for Portugal and 80 articles for France. The selected documents were categorized into thematic areas of skills, enabling a structured comparison between the two countries and providing a holistic view of the demands imposed by Industry 4.0.

2.3. Bibliometric and Qualitative Analysis

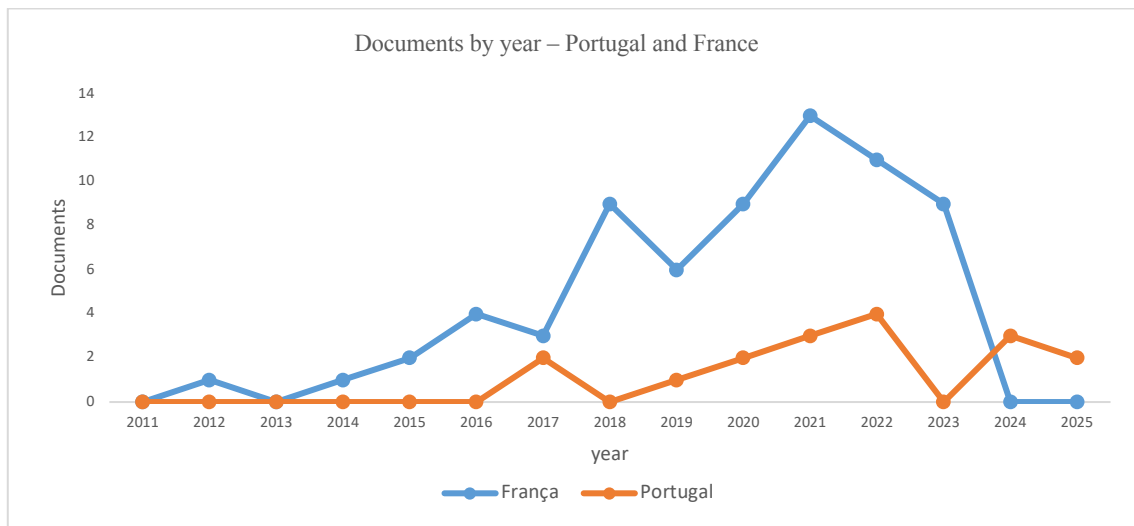
For both datasets, the analysis was conducted using RStudio (version 2024.09.0+375) with the Bibliometrix package [3]) and its graphical interface Biblioshiny, which facilitated data management, visualization, and the execution of advanced bibliometric analyses. Figures and maps were generated to explore publication patterns, collaboration networks, keyword co-occurrence, and thematic evolution. In addition, a qualitative analysis by domains was carried out, classifying skills into six main categories: technical, flexibility, inter-agency interaction, soft skills, innovation, and information technology, as well as an additional category labeled “other”.

3. RESULTS

The results of this study, obtained through bibliometric analysis and literature review, provide a comparative overview of the skills required for Industry 4.0 in Portugal and France. The analysis enabled the identification of both convergences and national specificities, highlighting differences in scientific production, thematic focus, and skill priorities associated with Industry 4.0 ([18]; [19]).

3.1. Scientific output and evolution of publications

In both countries, a significant increase in scientific output related to Industry 4.0 has been observed, particularly since 2016. In Portugal, there is a notable and consistent presence in international publications, reflecting the country's efforts to align with global trends and promote the development of professional skills oriented toward digitalization([20]; [21]). In France, a longer research trajectory is also evident, with records dating back to 2011 that have intensified significantly in recent years, particularly in areas related to artificial intelligence, big data, and digital health ([22]; [23]). Figure 1 illustrates these dynamics, highlighting both the recent expansion of Portuguese scientific production and the consolidation of the French research tradition, which has gained greater robustness alongside global technological advances.



*Figure 1 : Documents by year, Portugal and France
(Source: Authors, 2026)*

The following section presents the most relevant areas of knowledge in each country within the context of Industry 4.0.

3.2. Areas of knowledge and thematic scope

The distribution of publications in Portugal is mainly concentrated in the fields of Engineering, Computer Science, and Management and Business, indicating a strong emphasis on technical and innovation oriented skills related to Industry 4.0 ([24]; [25]). In France, in addition to these areas, research in Medicine, Social Sciences, and Mathematics stands out significantly, reflecting a more interdisciplinary and comprehensive approach that connects technology with health, education, and sustainability ([26]). Figure 2 illustrates these differences, highlighting the more technical focus observed in Portugal and the broader thematic scope found in France, which reinforces its tradition of integrating multiple scientific fields into the debate on digitalization and technological transformation.

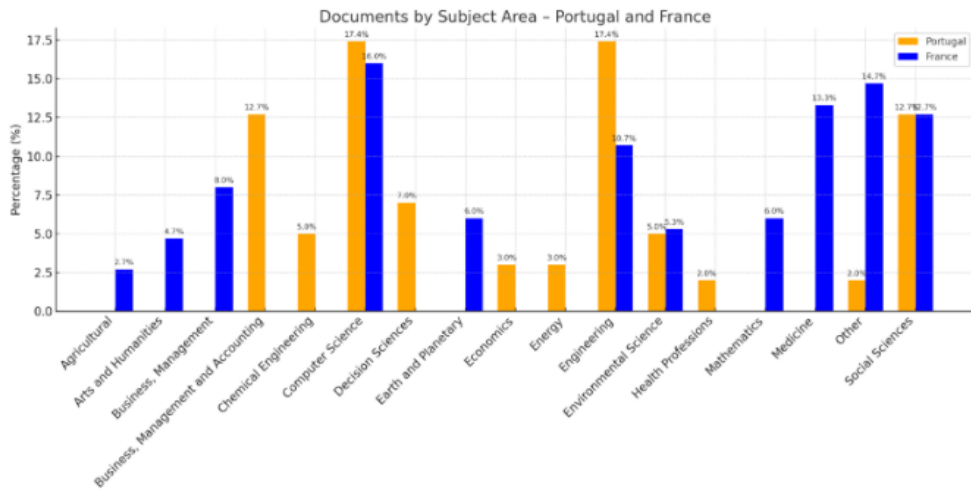


Figure 2 : Documents by subject area – Portugal and France
(Source: Authors, 2026)

In this context, the following section deepens the analysis of thematic trends and the most recurrent keywords, allowing the identification of central focuses, convergences, and specificities that characterize the debate on skills for Industry 4.0 in Portugal and France.

3.3. Thematic trends and keyword analysis

Word clouds and cluster analyses revealed different emphases, as illustrated in Figure 3 for Portugal and Figure 4 for France. In Portugal, terms such as management, skills, and digitalization appear frequently, reflecting concerns related to professional education and the adaptation of workers to labor market demands ([27]). In France, by contrast, words such as artificial intelligence, data, skills, and development were predominant, indicating a stronger focus on emerging technologies and their application across different social sectors ([28]).



Figure 3 : Keyword analysis – Portugal
(Source: Authors, 2026)



Figure 4 : Keyword analysis – France
(Source: Authors, 2026)

In this regard, the temporal analysis of keywords contributes to a deeper understanding of research trends and the evolution of scientific debates within each national context.

3.4. Evolution of keyword growth in the field of Industry 4.0

Figure 5, referring to Portugal, shows gradual, stable growth in keywords associated with Industry 4.0, with particular emphasis on competitiveness, digital transformation, and cyber-physical systems.

This evolution reflects a progressive consolidation of the theme, mainly driven by organizational restructuring, industrial competitiveness, and workforce qualification ([12]).

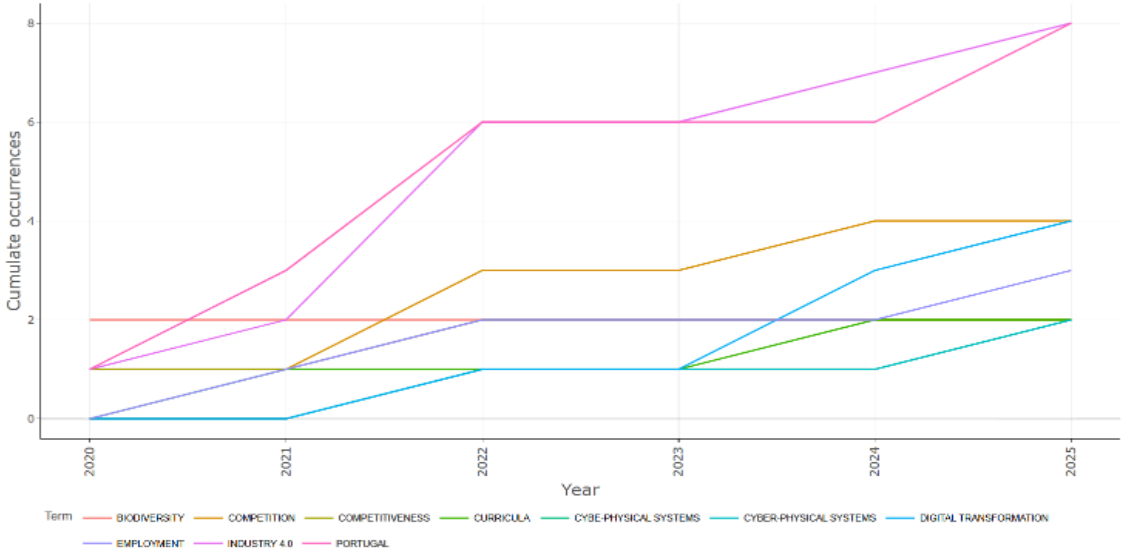


Figure 5 : The growth of keywords over time – Portugal (Source: Authors, 2026)

In contrast, Figure 6, referring to France, reveals a more accelerated and diversified growth, especially from 2018 onwards. Terms such as artificial intelligence, big data, and human(s) show a significant increase. At the same time, industry maintains a continuous presence, reflecting a strong orientation toward emerging technologies and their interactions with human and social dimensions ([29]; [30]).

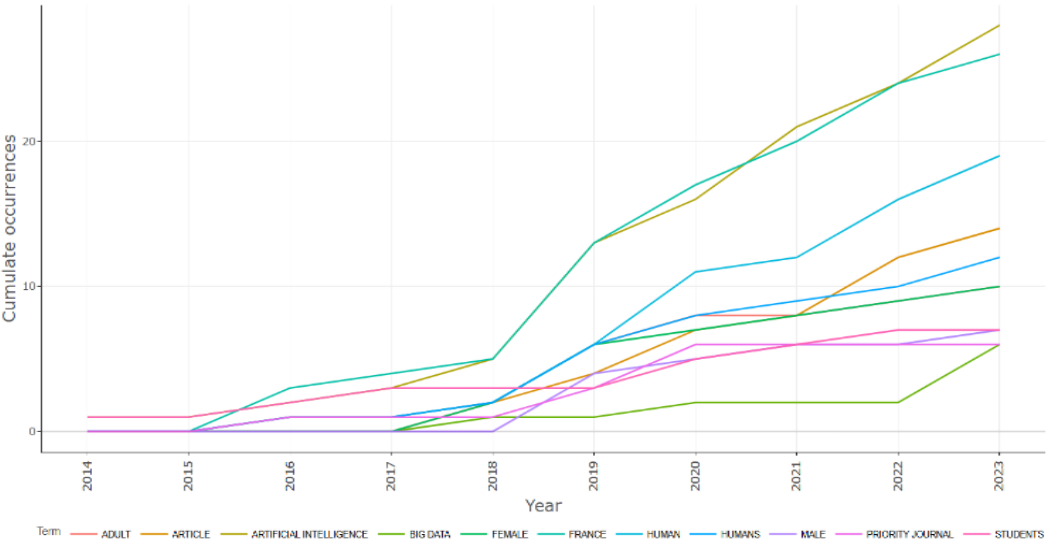


Figure 6 : The growth of keywords over time – France (Source: Authors, 2026)

From a comparative perspective, the results indicate that Portugal exhibits a more linear, incremental evolution, centered on the structural and organizational aspects of Industry 4.0. In contrast, France demonstrates a more intensive and technologically oriented approach, with a strong emphasis on artificial intelligence and data. These differences reflect distinct stages of scientific development and national innovation strategies, reinforcing the relevance of comparative analysis for understanding the specificities of the debate on skills and Industry 4.0 in each country. Complementing the evolutionary analysis of keywords, the investigation advances toward the thematic structuring of scientific output. The thematic map allows simultaneous assessment of the centrality and density of themes, highlighting consolidated, emerging, and strategic areas within Industry 4.0.

3.5. Evolution of the thematic map of keywords

Figure 7 and 8 present the thematic maps of keywords for Portugal and France, respectively, organizing themes into quadrants according to their degree of relevance, measured by centrality, and their level of development, measured by density. This approach enables the identification of motor, niche, emerging, or basic themes, providing a strategic interpretation of the intellectual structure of Industry 4.0 research.

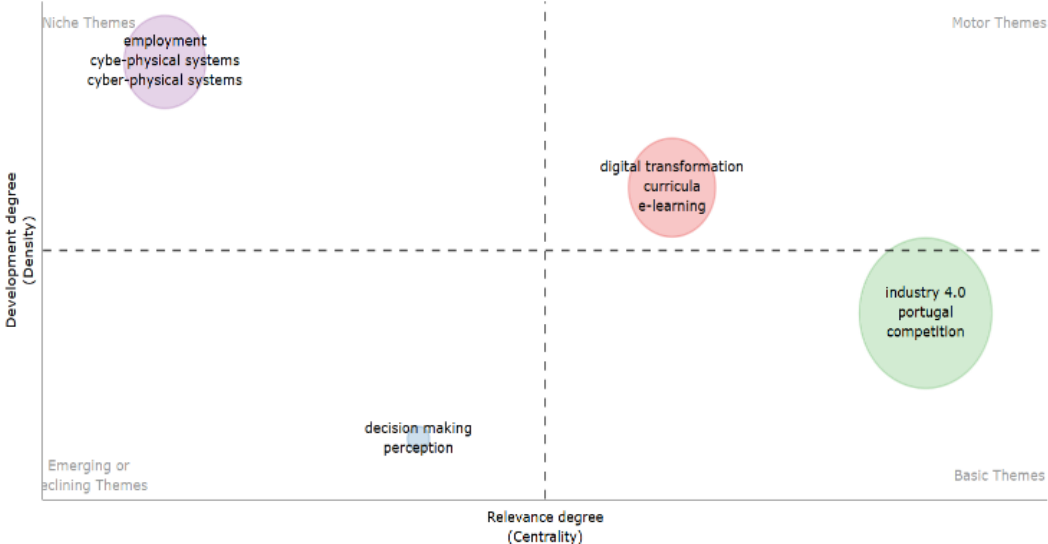


Figure 7 : Thematic map of keywords categorizes – Portugal (Source: Authors, 2026)

In the case of Portugal, as shown in Figure 7, basic and general themes such as Industry 4.0, Portugal, and competition predominate, indicating high relevance but lower conceptual density. This pattern reflects a body of literature focused on competitiveness, organizational transformation, and professional education, with a particular emphasis on motor themes related to digital transformation, curricula, and e-learning. In contrast, themes such as decision-making and perception emerge as emerging topics, suggesting fields that are still in the process of consolidation ([31]).

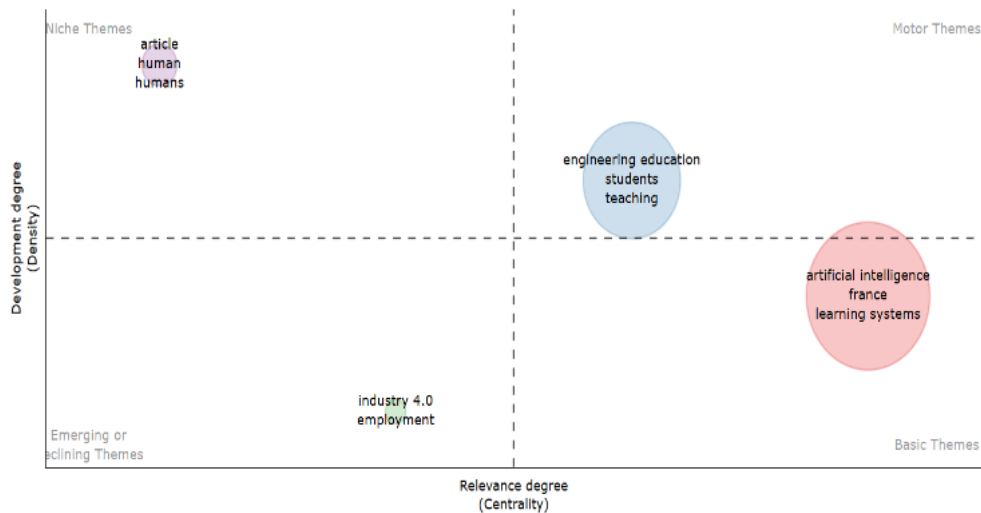


Figure 8 : Thematic map of keywords categorizes – France
(Source: Authors, 2026)

In turn, the thematic map for France, shown in Figure 8, reveals a more mature and technologically intensive structure. Motor themes are concentrated on artificial intelligence, learning systems, and engineering education, indicating high centrality and greater thematic density. In addition, the emergence of new themes related to Industry 4.0 and employment suggests an expansion of the debate to encompass the social and labor impacts of advanced technologies. From a comparative perspective, the results indicate that Portugal exhibits a more incremental evolution oriented toward organizational and educational structuring. In contrast, France demonstrates greater thematic consolidation and a stronger focus on advanced technologies, particularly artificial intelligence and learning systems. These differences reflect distinct national strategies in scientific production and in the prioritization of skills associated with Industry 4.0 ([32]; [31]).

4. CONCLUSION

This study aimed to present a comparative analysis between Portugal and France, grounded in systematic literature reviews and bibliometric analyses conducted in both countries, to understand the main research trends, existing gaps, and strategic directions related to skills development and training in the context of Industry 4.0 and Artificial Intelligence. By adopting a comparative approach, the research sought not only to map the most recurrent skills domains but also to highlight structural and conceptual differences between the two national contexts, thereby providing insights into how economic, technological, and institutional factors influence educational and professional priorities. The qualitative analysis of the selected articles revealed that the essential skills for the labor markets in Portugal and France, within the context of Industry 4.0 and Artificial Intelligence, can be grouped into six main domains, though with varying emphases across the countries.

ACKNOWLEDGEMENT: The authors would like to thank the Center for Studies in Governance, Competitiveness and Public Policies (GOVCOPP) at the University of Aveiro (UA) – Portugal, and the “Organizations and Society” research laboratory at Federal University of Technology – Paraná (UTFPR) – PG – Brazil.

Funding: This work was supported by the National Council for Scientific and Technological Development (CNPq) – Research Productivity Scholarship – PQ.

Ethics declaration: Not applicable.

Conflict of interest: The authors declare that they have no financial or non-financial conflicts of interest that could have influenced this research

LITERATURE

- [1] L. S. Dalenogare, G. B. Benitez, N. F. Ayala, and A. G. Frank. "The expected contribution of Industry 4.0 technologies for industrial performance.," *International Journal of Production Economics*, vol. 204, p. 383–394, 2018.
- [2] Y. Liao, F. Deschamps, E. F. R. Loures and L. F. P. Ramos. "Past, present and future of Industry 4.0: A systematic literature review and research agenda proposal," *International Journal of Production Research*, 55(12), pp. 3609-3629, 2017.
- [3] K. Schwab. "The Fourth Industrial Revolution.," in *World Economic Forum.*, 2016.
- [4] J. Leng, D. Wang, W. Shen, X. Li, Q. Liu, and X. Chen. "Digital twins-based smart manufacturing system design in Industry 4.0: A review.," *Journal of Manufacturing Systems*, 60, p. 119–137, 2021.
- [5] F. Hecklau, M. Galeitzke, F. S. and H. Kohl. "The influence of digitalization on the workforce in Industry 4.0," in *Proceedings of the 49th CIRP Conference on Manufacturing Systems*, 1., 2016.
- [6] L. H. Belina, F. W. Mateo, M. A. D. Freitas Junior, C. T. Picinin and C. R. Piazer T. "Skills for industry 4.0: A comparative perspectives of Brazilian and Argentine managers.," *Social Sciences & Humanities Open*, vol. 12, pp. 101771-101784, 2025.
- [7] C. R. P. Turcato, B. Pedroso, M. Arnold and C. T. Picinin. "Adapting to Industry 4.0 in France: Essential Competencies for a Future-Ready Workforce.," *Administrative Sciences*, vol. 14, pp. 322-350, 2024.
- [8] C. Cimini, A. Boffelli, A. Lagorio, M. Kalchschmidt, and R. Pinto. "How do Industry 4.0 technologies influence organisational change? An empirical analysis of Italian SMEs.," *Journal of Manufacturing Technology Management*, 32(3), p. 695–721., 2021.
- [9] G. T., Waldmann, C. T., Picinin, C., Lievore, and P., Rubbo. "Anxiety, depression and quality of life in industry: what are the existing intersections?," *Revista De Gestão E Secretariado*, 14(3), p. 2938–2962, 2023.
- [10] G. C. Girardi, P. Rubbo, E. E. Broday, M. Arnold and C. T. Picinin. "Comparative Analysis between Quality of Life and Human Labor in Countries Belonging to G7 and BRICS Blocks: Proposition of Discriminant Analysis Model.," *Economies*, vol. 12(5), pp. 124-143, 2024.
- [11] G., Santos, J. C., Sá, M. J., Félix, L., Barreto, F., Carvalho, M., Doiro, K., Zgodavová, and M., Stefanović. "New needed quality management skills for quality managers 4.0," *Sustainability*, 13(11), p. 6149, 2021.
- [12] L. P. S., Rita, J. A. R. da, Silva, S. B., Uchoa, I. M., Bittencourt, and J., Pinto Filho. "Digital transformation: patents as a determinant proxy for Industry 4.0. .," *International Journal of Innovation*, 12(3), vol. 20(2), p. e25326, 2024.
- [13] C. C. D., Amarante, D. N., Resende, E. E., Broday, and C. T., Picinin. "Trends in study topics related to quality of life in Industry 4.0: A bibliometric analysis.," *WORK: A Journal of Prevention, Assessment & Rehabilitation*, vol. 76(4), pp. 1357-1372, 2023.
- [14] C. T. Picinin, B. P. M. Arnold, R. V. Klafke and e. G. M. C. Pinto. "The Relevance of Soft Skills for Industry 4.0.," in *In: Zimmermann, R., Rodrigues, J.C., Simoes, A., Dalmarco, G. (eds) Human-Centred Technology Management for a Sustainable Future. IAMOT 2024. Springer Proceedings in Business and Economics. Springer, Cham.*, 2024.
- [15] C., Guzmán Sánchez-Mejorada, M., Torres-Ruiz, R., Quintero, K. T., Chui, and G., Guzmán. "Industry 4.0 skills assessment: A case study of students' perceptions in computer science postgraduate programs.," *Sustainability*, 17(11), p. 4974., 2025.
- [16] R. Teixeira, A. Gonçalves and J. Taylor. "Digital transformation in universities: Adaptation and challenges in the era of Industry 4.0," *Journal of Higher Education*, 28(2), pp. 157-172, 2021.

- [17] M. Aria and e. C. Cuccurullo. "Bibliometrix: An R-Tool for Comprehensive Science Mapping Analysis," *Journal of Informetrics* 11, no. 4, p. 959–975, 2017.
- [18] T. D. A. Savu. "Work-in-Progress: Developing a Master Programme for Specialists in Industry 4.0.," vol. 1192, 2021.
- [19] T. Colin, B. Delmas and e. M. Lefebvre. "France: NEWMOTOR: An HR Policy to Develop New Skills at a French Company in the Aeronautics Industry," in *In The Global Human Resource Management Casebook, 3rd ed*, 2023.
- [20] B. S. A. R. J. Faria. "Impact of Governmental Support for the Implementation of Industry 4.0 in Portugal.," n: Machado, J., Soares, F., Trojanowska, J., Ivanov, V. (eds) *Innovations in Industrial Engineering. icieng 2021. Lecture Notes in Mechanical Engineering. Springer, Cham*, 11(3), 2022.
- [21] S. Campos and C. S., Silva. "Synergies between quality management and knowledge management: 4.0 shop floor competency management model.," *In Proceedings of the 5th International Conference on Quality Engineering and Management: A Better World with Quality! Quality in the Digital Transformation*, 2022.
- [22] O. Bonnaud. "National Recovery Plan for the Electronics Industry in France; Importance of Training in the Field," *In Proceedings of the 2021 30th Annual Conference of the European Association for Education in Electrical and Information Engineering*, 2021.
- [23] I. Georgieva, V. Gechev, G. Georgiev and e. M. Ivanova. "Developing Capacity through PLC Training Implementation for Industry 4.0.," in *In Proceedings of the International Scientific Conference "Industry 4.0: Challenges, Trends and Solutions*, 2022.
- [24] J. Moniz, P. Candeias and A. Boavida. "Impact of artificial intelligence on productivity and labor relations in the automotive sector in Portugal" *Studies on Work*, 15(3), pp. 98-115, 2022.
- [25] J., Jeranoski, and P., Leitão. "Development of Stem Curriculum for Digital Electronics Education in Secondary School," *Global Engineering Education Conference (EDUCON 2024)* , Kos, Grécia: IEEE, pp. 1-7, 2024.
- [26] A. Kalel, J. Zhou, S. Zhang and e. M. Wang. "The Role of Neglect of Exclusivity in Human-Chatbot Interactions," *International Journal of Human-Computer Interaction* 39, no. 5, p. 469–479, 2023.
- [27] C., Neves, S., Silva, and D., Martins. "The competences in the digital era in the tourism and hospitality sector.," *In Proceedings of the International Conference on Tourism Research* , pp. 423-429, 2021.
- [28] K. Boursicot, P. Hays, M. Diemers, M. Billon, S. Perrier, C. Jones and D. C. Goodyear. "Synthesis and Perspectives from the Ottawa 2022 Conference on the Assessment of Competence," *Medical Teacher* 45, no. 9, p. 978–983, 2023.
- [29] D. Fister, M. A. A. Nemeth and L. Vidmar. "Accurate Long-Term Air Temperature Prediction with Machine Learning Models and Data Reduction Techniques," *Applied Soft Computing* 136, 2023.
- [30] A. Tiwari, R. Bahuguna and S. Srivastava. "Smart Manufacturing and Sustainability: A Bibliometric Analysis," *Journal of Cleaner Production* 322, p. 1–17, 2022.
- [31] T. Dieguez. "Digital Transformation and Organizational Challenges. An Exploratory," *Lecture Notes in Mechanical Engineering*, p. 629–36., 2024.
- [32] E. Cunha. "Skills needed for accountants in the digital age: A curriculum review," *Accounting and Management*, 15(2), pp. 98-112, 2022.

TECHNOLOGICAL ORIENTATION AS A DRIVER OF CONVENTIONAL AND ECO-INNOVATIONS IN HOSPITALITY: A CONCEPTUAL FRAMEWORK

Jasmina Sladoljev

*Šibenik University of Applied Sciences
jasmina@vus.hr*

Dijana Mecev

*Šibenik University of Applied Sciences
dijana@vus.hr*

Franka Sladoljev

*Šibenik University of Applied Sciences
fladolj@vus.hr*

ABSTRACT

In contemporary hospitality, characterized by rapid digital transformation and increasing sustainability pressures, technological orientation is increasingly recognized as a key strategic driver of innovation. Despite growing academic interest in the relationship between technology and innovation, existing research rarely differentiates the effects of technological orientation on different types of innovations, particularly conventional and eco-innovations. The aim of this paper is to propose a conceptual framework that explains the role of technological orientation as a driver of both conventional and eco-innovations in the hospitality sector, based on a review of relevant literature. Adopting a theoretical approach, the paper synthesizes key concepts related to technological orientation and the characteristics of different types of innovations in hospitality. As a result, two conceptual models are proposed, highlighting the potentially differentiated effects of technological orientation on the development of conventional and eco-innovations. This study contributes to the literature by clarifying the role of technological orientation in hospitality innovation and by providing a theoretical foundation for future empirical research and managerial decision-making.

Keywords: *technological orientation, conventional innovations, eco-innovations, hospitality, conceptual framework*

1. INTRODUCTION

The service sector is considered one of the fastest-growing segments of the global economy, with a significant contribution to gross domestic product. Within this sector, tourism plays a particularly important role due to its continuous contribution to the global economy. Within the tourism system, hospitality firms represent the central receptive element of the supply and play a significant role in shaping destination competitiveness. At the same time, the tourism and hospitality industries operate in conditions of intense global competition, rapid technological advancement, and changing consumer preferences. The growth of tourism over recent decades has been accompanied by strong pressure on firms' innovativeness (Vodeb, 2012; Backman et al., 2017). In this context, innovation is recognized as a key prerequisite for business survival, competitiveness, and the long-term growth of hospitality firms (Orfila-Sintes and Mattsson, 2009). Contemporary concepts of competitiveness increasingly integrate digital transformation, innovation, and sustainable business practices as interrelated strategic dimensions (Haldorai et al., 2023; Park et al., 2024). At the same time, hospitality firms are significant consumers of energy and water and major producers of waste and emissions that negatively affect the environment (Makoondlall-Chadee and Bokhoree, 2024).

Consequently, ensuring the sustainable growth of tourism while preserving natural and cultural heritage has emerged as one of the key priorities of contemporary sector development (WTTC, 2020; WTTC, 2024). In this context, increasing emphasis is placed on the systematic implementation of sustainability measures and the monitoring of environmental performance, as reflected in initiatives aimed at the standardized measurement of carbon emissions in hotels (World Sustainable Hospitality Alliance, 2023). The literature further emphasizes the importance of a high level of commitment to technology as a response to changing technological conditions, highlighting the need to adopt efficient technologies in order to develop new and improved products and services. Previous research confirms that an orientation toward innovation represents one of the key strategies for achieving market success (Gatignon and Xuereb, 1997; Brem and Voigt, 2009). In the hospitality sector, innovation development is closely linked to firms' internal resources and strategic orientations, among which technological orientation is particularly prominent. Technological orientation refers to an organization's readiness to systematically monitor, adopt, and implement new technologies in business processes, products, and services, thereby creating the preconditions for more intensive innovation activity. Although numerous studies confirm a positive relationship between technological orientation and innovation, innovation is still predominantly treated as a single and homogeneous construct in much of the existing literature. However, contemporary research increasingly distinguishes between conventional innovations—primarily aimed at improving efficiency, quality, and market position—and eco-innovations, whose primary objective is to reduce the negative environmental impact of business activities while generating economic and social benefits (Triguero et al., 2013). Despite growing interest in eco-innovations, particularly in the context of sustainability, research addressing their determinants in the hospitality sector remains limited and fragmented (Menezes and Cunha, 2016; García-Pozo et al., 2015). Existing studies on innovation in tourism and hospitality indicate the need for a deeper understanding of the factors that drive different types of innovation, including eco-innovations (Hjalager, 2010; Pivčević and Petrić, 2011; Grisseman et al., 2013; Aboelmegeed, 2018; Asadi, 2020). Researchers emphasize the need for conceptual differentiation of innovation determinants and for examining their differentiated roles within the hospitality sector (Orfila-Sintes et al., 2005; Pikkemaat, 2008; Hjalager, 2010; Pikkemaat et al., 2019). Drawing on the resource-based view (RBV), which highlights the importance of internal resources and capabilities in achieving competitive advantage (Barney, 1991; 2001), technological orientation can be viewed as a key strategic resource that enables the development of innovation capabilities in hospitality firms. Nevertheless, the literature still provides limited insight into how technological orientation functions as a driver of different types of innovation, particularly in the context of conventional and eco-innovations. Accordingly, the aim of this paper is to propose, based on a review of relevant literature, two conceptual frameworks that explain the role of technological orientation in fostering innovation activities in the hospitality sector. The first conceptual framework focuses on examining the relationship between technological orientation and different forms of conventional innovation, while the second framework addresses the role of technological orientation in the development of eco-innovations. This theoretical study seeks to contribute to a better understanding of the differentiated effects of technological orientation on innovation and to provide guidance for future empirical research in the field of hospitality and sustainable business.

2. THEORETICAL FRAMEWORK

2.1. Resource-Based View as a Theoretical Foundation for Innovation

Firm performance is largely conditioned by the availability of internal resources and capabilities, whereby the combination of tangible and intangible resources shapes firms' competitive positions.

In this context, this study draws on the resource-based view (RBV), which emphasizes that unique and difficult-to-imitate resources and organizational capabilities are key sources of sustained competitive advantage (Barney, 1991; 2001). RBV provides a theoretical framework for understanding innovation as an outcome of strategic management of internal resources, with innovation performance interpreted as the result of effective combinations of knowledge, technology, and organizational capabilities. Beyond explaining conventional innovations, RBV has increasingly been applied in the context of eco-innovations, where environmental challenges are viewed as opportunities for developing new capabilities and sources of competitive differentiation (Hart and Dowell, 2011). Nevertheless, the application of RBV in green innovation research within the hospitality sector remains underdeveloped (Khanra et al., 2022), indicating the need for further conceptual advancement.

2.2. Technological Orientation as a Strategic Resource

Within the RBV framework, technological orientation can be viewed as a strategic resource that significantly influences a firm's innovation potential. Technological orientation refers to a firm's ability and willingness to continuously acquire, develop, and apply new technological knowledge in the development of products and services, as well as in the improvement of business processes (Cooper, 1994; Workman, 1993). Technological resources and capabilities enable the creation of competitive advantages that are difficult to imitate, particularly in dynamic and uncertain environments (Voudouris et al., 2012). In this context, technological orientation—manifested through a strong commitment to research and development and the systematic application of new technologies—is recognized as an important driver of innovation activities and long-term firm competitiveness (Gatignon and Xuereb, 1997; Tutar et al., 2015).

2.3. Conventional Innovations

In the literature, conventional innovations are most commonly classified based on the distinction between technological and non-technological innovations (Grčić Fabić, 2015). Technological innovations encompass product or service innovations and process innovations, while non-technological innovations include organizational and marketing innovations (Damanpour and Aravind, 2012; Camisón and Villar-López, 2014). Product and service innovations refer to the introduction of new or significantly improved solutions that are new to the firm, whereas process innovations involve improvements in production or service delivery aimed at increasing operational efficiency (Stevanović, 2012). Organizational innovations include the implementation of new methods in business practices and work organization, while marketing innovations involve new marketing concepts and strategies related to product design, promotion, distribution, or pricing (OECD and Eurostat, 2005). In accordance with the Oslo Manual, this study conceptualizes conventional innovations across four core dimensions: product/service innovations, process innovations, organizational innovations, and marketing innovations, which are primarily oriented toward improving efficiency, quality, and firms' market competitiveness.

2.4. Eco-Innovations

Eco-innovations encompass innovative products, processes, and practices that reduce negative environmental impacts while simultaneously creating economic value (Rennings, 2000). They do not necessarily emerge solely in response to environmental requirements but may also result from technological progress, organizational changes, or improvements in resource efficiency (Bartlett and Trifilova, 2010). In accordance with the Oslo Manual and the methodological framework of the Measuring Eco-Innovation project, eco-innovations can be classified into product, process, organizational, and marketing eco-innovations (Kemp and Pearson, 2008; Horbach, 2014).

In the hospitality sector, eco-innovations are most commonly associated with energy efficiency, rational resource use, and waste reduction, as hotels seek to align their operations with sustainable development goals and growing market expectations (Kweon Soonwook et al., 2023).

2.5. Technological Orientation and Innovation Outcomes

Previous research indicates that technologically oriented firms are more likely to adopt advanced technological solutions and achieve higher levels of innovativeness, as reflected in the development of technologically advanced products and processes (Gatignon and Xuereb, 1997; Voss and Voss, 2000). A higher level of technological orientation is also associated with improved business performance, as it facilitates the development and implementation of innovations and enhances firms' ability to adapt to market and technological changes (Voss and Voss, 2000). Technological orientation encourages investments in research and development, systematic monitoring of technological trends, and the accumulation of technological knowledge, thereby increasing firms' ability to identify and exploit new technological opportunities (Gatignon and Xuereb, 1997). In this sense, technological orientation represents an important foundation for achieving diverse innovation outcomes. However, empirical findings in this area remain inconclusive. While some studies confirm a strong positive effect of technological orientation on eco-innovations, particularly in contexts characterized by regulatory pressures and sustainability requirements (Horbach, 2008; Cai and Li, 2018), others suggest that technological capabilities exert a stronger influence on conventional innovations than on green innovations (Cuerva et al., 2014). This inconsistency in findings further highlights the need for conceptual differentiation and deeper theoretical examination of the differentiated effects of technological orientation on various types of innovation.

2.6. Technological Orientation as a Driver of Innovation: Implications for Conceptual Frameworks

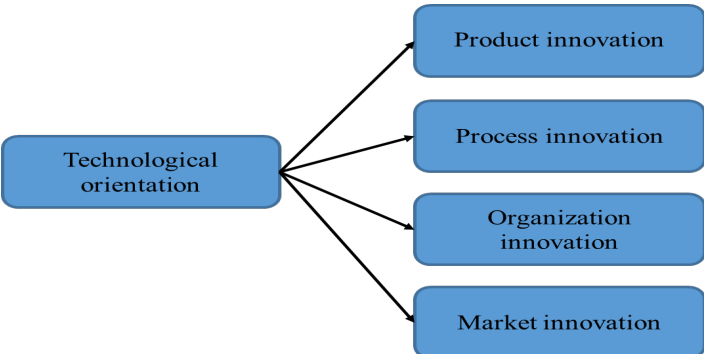
The preceding discussion highlights technological orientation as a key strategic resource that can stimulate firms' innovation activities. However, existing literature suggests that its effects vary across innovation types, as conventional and eco-innovations differ in their objectives, requirements, and levels of complexity. While conventional innovations primarily aim to enhance efficiency, quality, and market performance, eco-innovations additionally pursue environmental objectives and often require more specific technological and organizational capabilities. This distinction underscores the need to conceptually differentiate the effects of technological orientation across innovation types. Accordingly, this study proposes two conceptual frameworks: the first examines the relationship between technological orientation and conventional innovations, while the second focuses on the role of technological orientation in fostering eco-innovations in the hospitality sector. Together, these frameworks provide a foundation for a more nuanced understanding of the differentiated innovation effects of technological orientation and for future empirical research.

3. CONCEPTUAL FRAMEWORK

Building on the resource-based view (RBV), which emphasizes the role of internal resources and capabilities in achieving competitive advantage (Barney, 2001), technological orientation can be regarded as a key strategic resource that shapes firms' innovation activities. Technological orientation reflects a firm's openness to new ideas, commitment to research and development, and willingness to adopt and integrate new technologies into products, services, and processes (Gatignon and Xuereb, 1997). Previous research has predominantly examined the relationship between technological orientation and innovation by treating innovation as a homogeneous construct.

However, innovation activities differ in their objectives, scope, and outcomes, particularly when distinguishing between conventional innovations and eco-innovations. Conventional innovations primarily aim to improve efficiency, quality, and market performance, whereas eco-innovations are additionally oriented toward reducing environmental impacts and supporting sustainable development (Triguero et al., 2013). This distinction suggests that the effects of technological orientation may vary across different types of innovations. To address this gap, this study proposes two related conceptual models that explicitly differentiate between innovation outcomes. The first model focuses on the relationship between technological orientation and conventional innovations, while the second model examines the relationship between technological orientation and eco-innovations. Both models adopt the innovation typology commonly used in the Oslo Manual, encompassing product, process, organizational, and marketing innovations.

Figure 1. Conceptual model 1 - Technological orientation and conventional innovations

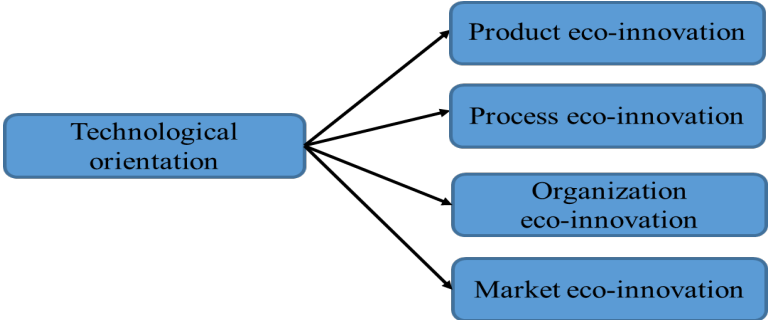


Source: Authors' own elaboration.

Conceptual Model 1 (Figure 1) proposes that technological orientation positively influences the development of conventional innovations in hospitality firms. Technologically oriented firms are more likely to invest in research and development, adopt advanced technologies, and experiment with new technological solutions. These capabilities facilitate the introduction of new or improved products and services, more efficient processes, innovative organizational practices, and advanced marketing approaches. Accordingly, technological orientation is expected to act as a key driver of product, process, organizational, and marketing innovations by enabling firms to exploit technological opportunities and respond proactively to market and competitive pressures.

Proposition 1 (P1): *Technological orientation positively influences conventional innovations in hospitality, including product, process, organizational, and marketing innovations.*

Figure 2. Conceptual model 2 - Technological orientation and eco-innovations



Source: Authors' own elaboration.

Conceptual Model 2 (Figure 2) extends the previous framework by focusing on eco-innovations. Eco-innovations represent a specific subset of innovations aimed at reducing environmental impacts. These innovations often require advanced technological knowledge, specialized capabilities, and continuous monitoring of technological developments related to energy efficiency, resource management, and environmentally friendly solutions. Technological orientation is therefore expected to play a crucial role in enabling eco-innovations, as firms with a strong technological focus are better positioned to identify, adopt, and implement sustainable technologies. However, given the additional regulatory, cost-related, and organizational challenges associated with eco-innovations, their relationship with technological orientation may differ from that observed for conventional innovations.

Proposition 2 (P2): *Technological orientation positively influences eco-innovations in hospitality, including product, process, organizational, and marketing eco-innovations.*

By distinguishing between conventional and eco-innovations, the proposed frameworks contribute to a more nuanced understanding of how technological orientation operates across different innovation domains in hospitality. The proposed models also provide a foundation for future empirical testing of differentiated innovation mechanisms in hospitality firms.

4. CONTRIBUTION OF THE CONCEPTUAL FRAMEWORK

By proposing two related but distinct conceptual models, this study contributes to the innovation and hospitality literature in three ways. First, it conceptually distinguishes between conventional innovations and eco-innovations as separate innovation outcomes. Second, it highlights technological orientation as a common strategic driver with potentially differentiated effects across innovation types. Third, it provides a structured framework that can serve as a foundation for future empirical research aimed at testing the proposed relationships in different hospitality and tourism contexts.

5. CONCLUSION

This paper develops a theoretical perspective on the role of technological orientation as a driver of innovation activities in the hospitality sector. Building on the resource-based view, the study proposes two conceptual frameworks that differentiate between conventional innovations and eco-innovations, thereby addressing a gap in the existing literature where innovation is often treated as a homogeneous construct. By explicitly distinguishing between different types of innovation outcomes, the proposed models offer a more nuanced understanding of how technological orientation influences innovation in hospitality firms. The first conceptual framework highlights the role of technological orientation in fostering conventional innovations aimed at improving efficiency, quality, and market performance. The second framework extends this perspective by emphasizing the importance of technological orientation in enabling eco-innovations, which are increasingly critical in the context of sustainability pressures and environmental responsibility. Theoretical contributions of this study lie in clarifying the differentiated mechanisms through which technological orientation operates across innovation domains and in integrating conventional and eco-innovations within a unified conceptual structure. From a managerial perspective, the proposed frameworks suggest that investing in technological capabilities and fostering a technology-oriented strategic mindset may support both competitiveness-driven and sustainability-driven innovation efforts in hospitality. As a conceptual study, this paper does not provide empirical validation of the proposed relationships. However, it offers a clear foundation for future empirical research aimed at testing the proposed models across different hospitality contexts and market settings. Overall, this study contributes to the ongoing discussion on innovation management in hospitality by emphasizing the strategic importance of technological orientation in shaping diverse innovation trajectories.

LITERATURE:

1. Aboelmegeed, M. (2018). Direct and indirect effects of eco-innovation, environmental orientation and supplier collaboration on hotel performance: An empirical study. *Journal of Cleaner Production*, 184, pp. 537–549.
2. Asadi, S., Pourhashemi, S. O., Nilashi, M., Abdullah, R., Samad, S., Yadegaridehkordi, E. et.al. (2020). Investigating influence of green innovation on sustainability performance: A case on Malaysian hotel industry. *Journal of Cleaner Production*, 258, p. 120860.
3. Backman, K., Klaesson, J. and Öner, T. (2017). Innovation in the hospitality industry: Firm or location? *Annals of Tourism Research*, 64, pp. 1–11.
4. Bartlett, D. and Trifilova, A. (2010). Green technology and eco-innovation: Seven case-studies from a Russian manufacturing context. *Journal of Manufacturing Technology Management*, 21(8), pp. 910–929.
5. Barney, J. B. (2001). Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. *Journal of Management*, 27(6), pp. 643–650.
6. Brem, A and Voigt, K-I., Integration of market pull and technology push in the corporate front end and innovation management-insights from the German software industry, *Technovation*, 29(5) (2009) 351-367.
7. Cai, W. and Li, G. (2018). The drivers of eco-innovation and its impact on performance: Evidence from China. *Journal of Cleaner Production*, 176, pp. 110–118.
8. Camisón, C. and Villar-López, A. (2014). Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of Business Research*, 67(1), pp. 2891–2902.
9. Chidamber S.R. and Kon, H.B. A research retrospective of innovation inception and success: The technology push demand-pull question, *International Journal of Technology Management*, 9(1) (1994) 1-27.
10. Cooper, Robert G. (1994), "New Products: The Factors that Drive Success," *International Marketing Review*, 11 (1), 60-76.
11. Cuerva, M. C., Triguero-Cano, Á. and Córcoles, D. (2014). Drivers of green and non-green innovation: empirical evidence in Low-Tech SMEs. *Journal of Cleaner Production*, 68, pp. 104–113.
12. Damanpour, F. and Aravind, D. (2012). Managerial Innovation: Conceptions, Processes, and Antecedents. *Management and Organization Review*, 8, pp. 423–454
13. García-Pozo, A., Sánchez-Ollero, J. L. and Marchante-Lara, M. (2015). Eco-innovation and management: an empirical analysis of environmental good practices and labour productivity in the Spanish hotel industry. *Innovation*, 17(1), pp. 58–68.
14. Gatignon and J-M. Xuereb, Strategic orientation of the firm and new product performance, *Journal of Marketing Research*, 34(1) (1997) 77-90.
15. Grčić Fabić, M. (2015). Menadžerske inovacije u funkciji razvoja učinkovitosti lokalne samouprave u Republici Hrvatskoj. Rijeka: *Ekonomski fakultet*, Rijeka.
16. Grissemann, U. S., Pikkemaat, B. and Weger, C. (2013). Antecedents of innovation activities in tourism: An empirical investigation of the Alpine hospitality industry. *Tourism Management*, 36, pp. 123–134.
17. Haldorai, K., Kim, W. G., Agmapisarn, C., and Li, J. J. (2023). Who we are and what we do: The relevance of green organizational identity in understanding environmental performance. *International Journal of Hospitality Management*, 114, 103574.
18. Hart, S. L. and Dowell, G. (2011). Invited editorial: A natural-resource-based view of the firm: Fifteen years after. *Journal of Management*, 37(5), pp. 1464–1479.
19. Horbach, J. (2014). Do eco-innovations need specific regional characteristics? An econometric analysis for Germany. *Review of Regional Research*, 34(1), pp. 23–38.
20. Hjalager, A. M. (2010). A review of innovation research in tourism. *Tourism Management*, 31(1), pp. 1–12.
21. Kemp, R. and Pearson, P. (2008). MEI project about measuring eco-innovation. Final report.
22. Khanra, S., Kaur, P., Joseph, R. P., Malik, A. and Dhir, A. (2022). A resource-based view of green innovation as a strategic firm resource: Present status and future directions. *Business Strategy and the Environment*, 31(4), pp. 1395–1413.

23. Kweon, S., Lee, J., Ku, D., Kwak, J., Kim, S. and Lee, S. (2023). Improvement of the Benefits for Eco-friendly Transportation Projects. *CET Journal-Chemical Engineering Transactions*, p. 106.
24. Makoondlall-Chadee, T. and Chandradeo, B. (2024). Understanding the Influencing Factors of Pro-Environmental Behavior in the Hotel Sector of Mauritius Island. *Tourism and Hospitality*, 5, pp. 942–976.
25. Menezes, V. de O. and Cunha, S. K. (2016). Eco-Innovation in Global Hotel Chains: Designs, Barriers, Incentives and Motivations. *Brazilian Business Review*, 13(5), pp. 108–128.
26. OECD and Eurostat (2005). Oslo Manual – Guidelines for Collecting and Interpreting Innovation Data (3rd Edition). Paris: OECD Publishing.
27. Orfila-Sintes, F., Crespi-Cladera, R. and Martínez-Ros, E. (2005). Innovation Activity in the Hotel Industry: Evidence from the Balearic Islands. *Tourism Management*, 25, pp. 851–865.
28. Orfila-Sintes, F. and Mattsson, J. (2009). Innovation behavior in the hotel industry. *Omega*, 37(2), ISSN 0305-0483, pp. 380–394.
29. Park, H., Lee, M., Back, K. J. and DeFranco, A. (2024). Is hotel technology a double-edged sword on customer experience? A mixed-method approach using big data. *Journal of Hospitality & Tourism Research*, 48(5), pp. 881–894.
30. Pikkemaat, B. (2008). Innovation in small and medium-sized tourism enterprises in Tyrol, Austria, *Entrepreneurship and Innovation*, 9(3), pp. 187–197.
31. Pikkemaat, B., Peters, M. and Bichler, B. F. (2019). Innovation research in tourism: Research streams and actions for the future. *Journal of Hospitality and Tourism Management*, 41, pp. 184–196.
32. Pivčević, S. and Petrić, L. (2011). Empirical evidence on innovation activity in tourism-the hotel sector perspective. *The business Review*, Cambridge, 17(1), pp. 142–148.
33. Rennings, K. (2000). Redefining innovation – eco-innovation research and the contribution from ecological economics. *Ecological Economics*, 32(2), pp. 319–332.
34. Stevanović, M. (2012). Odabir ideja u razvoju proizvoda. Doktorski rad, Zagreb, Fakultet strojarstva i brodogradnje.
35. Triguero, A., Moreno-Mondéjar, L. and Davia, M. A. (2013). Drivers of different types of eco-innovation in European SMEs. *Ecological Economics*, 92, pp. 25–33.
36. Tutar, H., Nart, S. and Bingöl, D. (2015). The effects of strategic orientations on innovation capabilities and market performance: The case of ASEM. *Procedia-Social and Behavioral Sciences*, 207, pp. 709–719.
37. Vodeb, K. (2012). Competitiveness of Frontier Regions and Tourism Destination Management. Additional contact information, *Managing Global Transitions*, 10(1) (Spring), pp. 51–68.
38. Voss, G. B. and Voss, Z. G. (2000). Strategic orientation and firm performance in an artistic environment. *Journal of Marketing*, 64(1), pp. 67–83.
39. Voudouris, I., Lioukas, S., Iatrelli, M. and Caloghirou, Y. (2012). Effectiveness of technology investment: Impact of internal technological capability, networking and investment's strategic importance. *Technovation*, 32(6), pp. 400–414.
40. Workman, John P. (1993), "Marketing's Limited Role in New Product Development in One Computer Systems Firm," *Journal of Marketing Research*, 30 (November), 405-21.
41. World Travel & Tourism Council (2020). Travel & Tourism – Global Economic Impact & Trends 2020. https://www.developmentaid.org/api/frontend/cms/file/2020/10/Global_Economic_Impact_Trends_2020.pdf [Accessed 07. 02.2026.].
42. World Travel & Tourism Council (2024). Travel & Tourism Economic Impact 2024: Global Trends. Dostupno na: <https://wttc.org/research/economic-impact> [Accessed 07.02. 2026.].

CHALLENGES OF THE MODERN WORLD AND THEIR IMPACTS ON MENTAL HEALTH IN THE EDUCATIONAL FIELD

Milena Borges Parente Thomazi

*Federal University of Technology – Paraná (UTFPR)
Doutor Washington Subtil Chueire 330, Ponta Grossa - PR, Brazil
milena.thomazi@ifto.edu.br*

Claudia Tania Picinin

*Federal University of Technology – Paraná (UTFPR)
Doutor Washington Subtil Chueire 330, Ponta Grossa - PR, Brazil
Aveiro University (UA), ESTGA, GOVCOPP Research Unit, Aveiro, Portugal
claudiapicinin@utfpr.edu.br*

Guilherme Moreira Caetano Pinto

*State University of Central-West (UNICENTRO)
Professor Maria Roza Zanon de Almeida Engineer Street, Irati – PR, Brazil
prof.guilhermecaetano@gmail.com*

Vitor Hugo dos Santos Filho

*State University of Maringa (UEM)
Av. Reitor Zeferino Vaz, S/N, Goioerê PR, Brazil
vhsfilho@uem.br*

David Nunes Resende

*Aveiro University (UA), ESTGA, GOVCOPP Research Unit, Aveiro, Portugal
Commander Pinho e Freitas Street 28, 3750-127 Águeda, Portugal
david@ua.pt*

ABSTRACT

Adolescent mental health has assumed a central role in contemporary scientific and educational agendas, especially in light of the challenges imposed by the modern world and its repercussions on well-being, social participation, and learning processes. In this context, the present study aimed to analyze the impacts of the challenges of the modern world on the mental health of students in the educational field. The research is justified by the growing incidence of psychological distress among adolescents of school age. Methodologically, this is a cross-sectional, field-based study with a quantitative approach and an exploratory-analytical objective, conducted with students aged 15 to 18 enrolled in secondary/technical education at three campuses of the Federal Institute of Tocantins (IFTO). The main results reveal a consistent pattern of anxiety and depressive symptomatology among students, with a concentration of moderate levels of anxiety, indicating clinically relevant distress. It is concluded that the challenges of the modern world exert significant impacts on mental health in the educational field, reinforcing the need for institutional strategies focused on prevention, support, and the promotion of adolescents' psychological well-being.

Keywords: *Mental Health, Anxiety, Depression, Challenges, Modern World*

1. INTRODUCTION

Adolescent mental health has gained prominence in contemporary scientific and educational agendas due to its effects on well-being, social participation, and learning processes. Evidence produced by international organizations and literature reviews indicates that internalizing disorders, such as anxiety and depression, represent a significant share of psychological distress at this stage of life, generating impacts that may accumulate throughout individual development

(Patton et al., 2016; World Health Organization, 2025). In the school context, aspects related to institutional climate and pedagogical organization, such as predictability of assessment processes, supportive relationships, perceived safety, and a sense of belonging show consistent associations with emotional outcomes and health-related quality of life (HRQoL) (OECD, 2017; OECD, 2021; UNESCO, 2025). These elements reinforce the role of the school as a relevant space for promoting adolescents' psychological well-being. In Brazil, recent surveys conducted with school populations indicate high prevalence of indicators of psychological distress, as well as inequalities associated with sex and social context (Antunes et al., 2022; Victo et al., 2024; Wendt et al., 2023). In federal education networks, such as the Federal Institute of Tocantins (IFTO), this information is particularly strategic, considering the territorial and organizational heterogeneities among campuses, with direct repercussions for the structuring of screening actions, initiatives aimed at school climate, and intersectoral coordination. In light of this scenario, the present study aimed to analyze the impacts of the challenges of the modern world on students' mental health in the educational field. The conduct of this research is justified from epidemiological, educational, and public management perspectives. From an epidemiological standpoint, internalizing disorders—especially anxiety and depression—constitute a relevant portion of psychological distress during adolescence, with potential to generate cumulative effects on social and academic functioning across the life course (Patton et al., 2016; World Health Organization, 2025). In the educational domain, factors such as school climate, sense of belonging, and pedagogical organization show consistent associations with well-being and academic engagement, reinforcing the school as a privileged setting for health promotion actions and early identification of risks (OECD, 2017; OECD, 2021; UNESCO, 2025). In the field of educational management, public networks such as IFTO operate in territories marked by socioeconomic inequalities and different levels of human development, which require the production of contextualized information to support planning, priority setting, and efficient allocation of resources (PNUD; IPEA; FJP, 2013).

2. THEORETICAL BACKGROUND

Anxiety is an emotion with an adaptive function, as it enhances vigilance and prepares the organism to face challenging or uncertain situations. However, when it manifests in a persistent and disproportionate manner and begins to generate clinically significant impairments in academic performance, social relationships, or self-care, it is characterized as an anxiety disorder. From a neuropsychological perspective, anxiety is associated with the activation of cortico-limbic networks involving the amygdala, hippocampus, insula, and prefrontal cortices, which are responsible for threat detection, evaluation, and regulation, in interaction with the autonomic and endocrine systems. These mechanisms explain the physiological, cognitive, affective, and behavioral changes observed in clinical practice (American Psychiatric Association, 2013, 2022; Barlow, 2002; Nobre; Freitas, 2021). In school contexts, higher levels of anxious and depressive symptoms tend to be associated with lower scores of health-related quality of life (HRQoL), often following a dose–response pattern. Quality of life refers to the individual's perception of their position in life, considering their culture, values, goals, and expectations, and is understood as a multidimensional construct encompassing physical, psychological, social relationship, and environmental domains. During adolescence, HRQoL has been assessed using validated instruments, with emphasis on the KIDSCREEN-27, which allows analyses by specific domains and comparisons between groups (Ariño; Bardagi, 2018; Graves; Hodge; Jacob, 2016; Lima; Fleck, 2009; Ravens-Sieberer et al., 2014; The WHOQOL Group, 1998). Among Anxiety Disorders are included, among others, selective mutism, separation anxiety disorder, specific phobia, social anxiety disorder, panic disorder, agoraphobia, and generalized anxiety disorder.

Obsessive–compulsive disorder, in turn, belongs to the grouping of Obsessive–Compulsive and Related Disorders and is not classified as an anxiety disorder, although it shares anxious elements in the clinical experience (American Psychiatric Association, 2022). This distinction is fundamental for the appropriate delimitation of the phenomenon and for the proper selection of assessment instruments. Depression falls within the spectrum of Depressive Disorders, which are characterized by depressed or irritable mood, anhedonia, and somatic and cognitive changes that result in functional impairment. Among the most prevalent conditions are major depressive disorder and persistent depressive disorder (dysthymia). In pediatric populations, disruptive mood dysregulation disorder describes a pattern of persistent irritability associated with recurrent behavioral outbursts (American Psychiatric Association, 2013; 2022). As a structuring space for socialization, the school can act simultaneously as both a protective and a risk factor for mental health. Pedagogical cultures strongly oriented toward performance metrics, competitive assessment systems, and rigid goals tend to intensify stress levels, especially when combined with low predictability and limited socioemotional support. Beyond the formal curriculum, the quality of relationships among students, teachers, and the institution constitutes a central determinant of well-being: experiences of bullying, social exclusion, and lack of consistent support are associated with greater vulnerability to internalizing disorders and conduct problems (Aldridge; McChesney, 2018; Juvonen; Graham, 2014; Steare et al., 2023). In many contexts, rapid and poorly structured institutional responses end up favoring low-resolutiveness solutions, such as the medicalization of school difficulties, without addressing the organizational and relational determinants of distress (Fish, 2022). It is important to emphasize that school climate is not limited to the application of rules and punishments, but also involves perceptions of procedural justice, predictability, subjective safety, respectful relationships, and opportunities for participation. These dimensions act as protective factors against daily stress and foster academic engagement (Grazia; Molinari, 2021; OECD, 2017; Thapa et al., 2013; UNESCO, 2025). In this sense, more predictable and inclusive school environments tend to be associated with better HRQoL scores, especially in domains related to the school environment and social support and peer group. The school experience exerts a direct influence on the construction of identity and self-esteem during adolescence. Practices of recognition, realistic expectations, and informative feedback foster the development of self-efficacy and engagement. Conversely, constant social comparison, stigmatizing labels, and experiences of humiliation undermine self-worth and increase emotional vulnerabilities. In the current context, digital ecologies intensify processes of comparison and the search for social validation, such as likes and comments, producing heterogeneous effects on self-concept and well-being that vary across individuals and over time (Odgers; Jensen, 2020; Sala; Porcaro; Gómez, 2024; Valkenburg et al., 2021; Valkenburg; Meier; Beyens, 2022). Emotional vulnerability in adolescence results from the interaction of multiple biopsychosocial processes. At the biological level, neurocognitive and hormonal transformations occur, along with the remodeling of circuits related to emotion, reward, and decision-making, which increase sensitivity to internalizing conditions when articulated with environmental contexts (Baker; Galván; Fuligni, 2025; Casey; Cohen; Galvan, 2025; Crone et al., 2022; Tetteh-Quarshie; Risher, 2023). From a psychosocial perspective, identity reorganization, the search for peer acceptance, and fragile support networks may intensify feelings of inadequacy and hopelessness. Recent evidence highlights the role of social feedback and comparisons, both offline and online, in the co-construction of adolescent identity (Branje et al., 2021; Crone et al., 2022; Letkiewicz et al., 2023; Valkenburg; Meier; Beyens, 2022). These processes are heterogeneous in nature and are moderated by factors such as sex/gender, age, individual history, including adverse childhood experiences, family conditions, and characteristics of the school environment, which influence the intensity and trajectory of symptoms over time (Danielsdóttir et al., 2024; Keyes; Platt, 2024; Murray et al., 2021; Steare et al., 2023).

At the institutional level, teachers' mental health and occupational well-being, as well as peer support among teachers, affect classroom climate and the management of crisis situations, producing indirect effects on learning and students' emotional outcomes (Cavallari et al., 2024; Dreer, 2023; Nwoko et al., 2023). This multiscale approach supports the analysis of moderators, such as sex and campus, and the interpretation of associations at the ecological school level. In the Brazilian context, there is evidence of institutional under-recognition of psychological distress during adolescence, including difficulties in identifying depression in health services and in school settings, which may delay interventions and worsen outcomes (Collins et al., 2024). National studies with school-based samples indicate high prevalences of indicators of psychological distress and Common Mental Disorders, as well as inequalities associated with sex and socioeconomic position (Antunes et al., 2022; Gratão et al., 2024; Victo et al., 2024). These findings reinforce the central role of school climate and environment, including experiences of bullying, safety, and belonging, as well as parental relationships, in shaping mental health outcomes, pointing to the need for systematic prevention and screening strategies in public schools (Carranza et al., 2024; Gratão et al., 2024; Malta et al., 2025).

3. METHODOLOGY

The present study is a cross-sectional, field-based investigation with a quantitative approach and an exploratory-analytical objective, conducted with students aged 15 to 18 enrolled in secondary/technical education at three campuses of the Federal Institute of Tocantins (IFTO): Formoso do Araguaia, Lagoa da Confusão, and Pedro Afonso. Standardized measures were applied to assess anxiety and depression using the Hospital Anxiety and Depression Scale (HADS), as well as health-related quality of life (HRQoL) using the KIDSCREEN-27 instrument. Data collection was carried out collectively and through self-administration in the classroom, conducted by a trained team following standardized instructions, after obtaining the Free and Informed Assent Form (TALE), the Free and Informed Consent Form (TCLE), and approval from the Research Ethics Committee (REC). Participants were students regularly enrolled in secondary/technical education at the three selected campuses, aged between 15 and 18 years. The sampling strategy adopted was an expanded convenience census, in which all eligible classes during the data collection period were invited to participate during regular class hours, following authorization from campus management and academic coordination. Students with active enrollment at IFTO, aged between 15 and 18 years, who agreed to participate in the research were considered eligible. For participants aged 15 to 17 years, both the student's assent (TALE) and the legal guardian's consent (TCLE) were required. For students aged 18 years, consent was provided by the participant themselves. Students outside the established age range, enrolled in other levels of education, and those whose questionnaires were not completed to an extent sufficient for score calculation were excluded. Data collection began after ethical approval and institutional authorization. At each campus, eligible classes received a brief in-class presentation of the study, including its objectives, procedures, risks and benefits, and information regarding confidentiality. Subsequently, students signed the TALE and legal guardians signed the TCLE; for students aged 18 years, only the participant's consent was required. When the TCLE had not yet been obtained, the invitation and consent form were sent by the school to legal guardians, with a defined deadline for return. The instruments were self-administered collectively in the classroom, in the presence of trained administrators and with standardized instructions, without inducing responses. A fixed order of completion was adopted, starting with the KIDSCREEN-27 followed by the HADS, in order to minimize order or anchoring effects, using the validated Brazilian versions of the instruments. At the end of the application, the questionnaires were placed in sealed envelopes and forwarded for data entry into an electronic spreadsheet, with double-checking for consistency. The data were coded alphanumerically, with no nominal identification of participants.

The analytical database was stored in a secure environment with restricted access to the research team. Questionnaires were entered into an electronic spreadsheet (Microsoft Excel) with double consistency verification.

4. RESULTS

A total of 111 students participated in the study, distributed across the three analyzed campuses and including both sexes. Regarding anxiety symptoms, a higher proportion of moderate anxiety was observed at the Lagoa da Confusão campus (44.12%) compared to Formoso do Araguaia (37.84%) and Pedro Afonso (35.00%).

With respect to mild depression, the highest proportion was recorded at the Pedro Afonso campus (40.00%), followed by Lagoa da Confusão (38.24%) and Formoso do Araguaia (35.14%). No cases of severe depression were identified at any of the campuses.

In the analysis by sex, severe anxiety was observed exclusively among female students (8.62%), with no cases identified among male students (0.00%). Moderate anxiety was also more frequent among females (44.83%) than among males (29.17%). Similarly, mild depression showed a higher prevalence among female students (43.10%) compared to male students (31.25%).

Regarding health-related quality of life (HRQoL), the highest overall percentage was found at the Formoso do Araguaia campus (69.58%), followed by Lagoa da Confusão (64.37%) and Pedro Afonso (63.52%). In the Social support and peer group domain, the highest percentage was observed at Lagoa da Confusão (70.29%). For the School environment domain, the highest value occurred at Formoso do Araguaia (72.43%). In the Autonomy and parent relations domain, the highest percentage was also recorded at Formoso do Araguaia (71.12%), while the lowest was observed at Pedro Afonso (60.36%).

Across all evaluated domains and in the overall HRQoL indicator, male students consistently presented higher percentages than female students. In the total indicator, the absolute difference was approximately 8.81 percentage points, with scores of 70.75% among males and 61.94% among females.

Screening using the HADS in the total sample (n = 111) indicated, for anxiety (HADS-A), a greater concentration at the moderate level (38.74%), with 4.50% classified as severe. For depression (HADS-D), there was a predominance of mild (37.84%) and moderate (26.13%) levels, with no cases of severe depression (0.00%) identified in the total sample.

When stratified by campus, moderate anxiety levels (HADS-A) were highest at Lagoa da Confusão (44.12%), followed by Formoso do Araguaia (37.84%) and Pedro Afonso (35.00%). For depression (HADS-D), the mild level was more frequent at Pedro Afonso (40.00%), followed by Lagoa da Confusão (38.24%) and Formoso do Araguaia (35.14%), with no occurrence of severe depression at any campus. In the sex-based analysis, severe anxiety was identified exclusively among female students (8.62%). In addition, both moderate anxiety (44.83%) and mild depression (43.10%) were more frequent among females compared to males (29.17% and 31.25%, respectively).

In the KIDSCREEN-27 scores for the total sample, the Social support and peer group domain showed the highest percentage (69.64%), followed by Psychological well-being (67.57%) and Physical activity and health (64.36%).

The lowest percentage was observed in the Autonomy and parent relations domain (63.04%). The overall HRQoL indicator was 65.74% on a scale from 0 to 100, in which higher values indicate better quality of life.

By campus, the overall HRQoL indicator was highest at Formoso do Araguaia (69.58%), followed by Lagoa da Confusão (64.37%) and Pedro Afonso (63.52%). Considering specific domains, Social support and peer group reached its highest percentage at Lagoa da Confusão (70.29%), while the School environment domain achieved its highest value at Formoso do Araguaia (72.43%). In the Autonomy and parent relations domain, the highest percentage was again observed at Formoso do Araguaia (71.12%), and the lowest at Pedro Afonso (60.36%). In comparisons by sex, KIDSCREEN-27 scores were consistently higher among male students across all HRQoL domains.

It is acknowledged that, due to the cross-sectional design and the specific school context of the three investigated campuses, the findings should be interpreted as associations, maintaining the distinction between symptom screening and clinical diagnosis. The results highlight a consistent pattern of anxious and depressive symptomatology among students. In the case of anxiety (HADS-A), the concentration at the moderate level suggests clinically relevant distress. Regarding depression (HADS-D), the predominance of mild and moderate levels, together with the absence of severe cases in the total sample, indicates a spectrum of complaints that, although not extreme, may compromise motivation and academic engagement. In the analysis by sex, a higher symptom burden was observed among females, including the exclusive presence of severe anxiety among female students, a pattern compatible with differences related to socialization, perceived stressors, and coping strategies during adolescence.

With respect to health-related quality of life (HRQoL), the hierarchy of domains proved informative. The Social support and peer group domain presented the highest scores, suggesting relatively preserved interpersonal relationships, whereas Autonomy and parent relations ranked among the domains with lower values, signaling possible tensions in the negotiation of autonomy and/or in the perception of parental support. The overall HRQoL indicator fell within an intermediate range, consistent with a profile of moderate well-being, in which strengths, such as peer relationships and psychological well-being, coexist with areas of greater vulnerability, such as autonomy and, in some contexts, the school environment. The differences observed among campuses indicate intranetwork variation. Formoso do Araguaia showed a tendency toward higher overall HRQoL scores and better evaluation of the school environment; Lagoa da Confusão stood out for higher scores in social support and peer group, as well as a higher proportion of moderate anxiety; and Pedro Afonso presented a higher frequency of mild depression. Although the study design does not allow causal inferences, such contrasts are plausible given differences related to school climate, available resources, academic organization, and local sociodemographic characteristics, which modulate the student experience. Coherence is observed across the different analytical axes: contexts with better HRQoL scores, especially in the domains of peer support and school environment, tend to present lower symptomatic pressure, whereas domains with lower scores, notably autonomy and parent relations, coincide with greater salience of emotional complaints. Taken together, the findings delineate a relevant map of risks and protective factors for educational planning, indicating as priority fronts the screening and support of anxious and depressive symptoms, with special attention to female students; interventions focused on school climate and sense of belonging, especially in campuses with poorer indicators; and actions aimed at strengthening family–school articulation to promote autonomy with support.

In line with recent manuals and syntheses, the American Psychiatric Association (2022) reaffirms the high burden of internalizing disorders during adolescence and the importance of screening strategies in school contexts, reinforcing the relevance of the screening conducted in this study. The results support the need to implement an institutional flow for mental health screening and care within the school environment. Periodic application of standardized instruments is recommended—HADS for anxiety and depression symptoms and KIDSCREEN-27 for HRQoL—on a semiannual basis, ensuring immediate support for students with elevated scores and referral according to protocols previously defined in collaboration with the psychosocial team. With regard to school climate, the findings reinforce the centrality of peer belonging and the need to improve pedagogical organization, especially in contexts where the School environment domain presented lower values. Strengthening practices that promote integration and support among students is recommended, such as peer mentoring, tutoring, and welcoming actions for new students, as well as adjustments to academic routines that reduce assessment peaks, make feedback criteria clearer, and decrease public exposure of errors. The results show that students' mental health is concretely embedded among the challenges of the modern world experienced in the educational environment. The significant presence of anxiety and depression symptoms, associated with intermediate levels of health-related quality of life, reveals a school routine marked by persistent emotional pressures. Differences observed between sexes and among campuses indicate that such challenges do not manifest homogeneously, being modulated by institutional contexts, interpersonal relationships, and distinct ways of experiencing and expressing psychological distress. Aspects such as peer support and the school environment proved to be relevant protective elements, while fragilities related to autonomy and family relationships suggest points of greater vulnerability in the face of contemporary demands that permeate the student experience.

4. CONCLUSION

This study mapped the presence of symptoms of anxiety and depression using the HADS, as well as Health-Related Quality of Life (HRQoL), assessed through the KIDSCREEN-27, across three campuses of the Federal Institute of Tocantins (Formoso do Araguaia, Lagoa da Confusão, and Pedro Afonso). The analyses considered comparisons by sex and by campus, producing a consistent and relevant descriptive overview for educational management. The screening results indicated a predominance of moderate-level anxiety and mild to moderate levels of depression, with no severe cases of depression identified in the total sample. When analyzed by sex, a higher symptomatic burden was observed in the female group, including the exclusive occurrence of severe anxiety among girls, a pattern frequently reported in school contexts. The campus-based analysis revealed distinct profiles. In Lagoa da Confusão, a higher proportion of moderate anxiety was identified, whereas in Pedro Afonso, mild depression was more frequent. Although the cross-sectional design does not allow causal relationships to be established, these differences are consistent with contextual variations across campuses and reinforce the importance of institutional strategies sensitive to local specificities. Regarding HRQoL, the KIDSCREEN-27 domains highlighted the centrality of relational dimensions and the school environment. The Social support and peers domain showed the highest scores, while Autonomy and parent relations ranked among the lowest. The global HRQoL indicator was situated at an intermediate level, with better results in Formoso do Araguaia, including in the School environment domain, and greater prominence of Social support and peers in Lagoa da Confusão. In sex-based comparisons, boys presented higher scores across all domains and in the total indicator; these differences should be interpreted in light of socialization patterns and ways of expressing emotional distress during adolescence. From a broader perspective, the study provides a robust situational diagnosis of anxiety, depression, and HRQoL—dimensions recognized as challenges of the modern world within the educational field—across three IFTO

campuses. The results offer comparable parameters by sex and by campus and outline a map of risks and protective factors that can inform school planning. The articulation between local empirical evidence, a theoretical–conceptual framework, and operational recommendations constitutes a solid basis for implementing continuous cycles of screening, intervention, monitoring, and replanning, with a focus on promoting well-being and improving the learning environment. Among the strengths of the study, the coherence between objectives and instruments stands out, as the combination of the HADS for symptom screening and the KIDSCREEN-27 for domain-based HRQoL assessment enabled a comprehensive reading of the school context. The standardized application of the instruments, the care taken to distinguish screening from clinical diagnosis, and fidelity to the descriptive design reinforce the consistency of the findings and their usefulness for educational management. The study’s limitations are mainly related to its cross-sectional design and the use of self-report measures. The cross-sectional nature restricts causal and temporal inferences, requiring caution in interpreting the observed associations. Self-report data may be subject to social desirability bias and to differences in how emotional distress is expressed across sexes. In addition, the sample size per campus is moderate, which reduces the power to detect more subtle contrasts. As an agenda for future research, the implementation of longitudinal follow-up is recommended to analyze trajectories of anxiety and depression symptoms and HRQoL over time. Conducting multiple waves of data collection throughout the academic year would make it possible to identify intra-individual changes and critical periods in the school calendar. The inclusion of contextual variables, such as aspects of academic routines and school transitions, may contribute to a more refined understanding of the observed variations, particularly in the School environment and Autonomy and parent relations domains. By analyzing the impacts of modern-world challenges on mental health in the educational context, this study demonstrates that the school is simultaneously a space of exposure to emotional tensions and a strategic field for promoting well-being. The evidence reinforces that dealing with intensified academic demands, performance expectations, social transformations, and transitional processes inherent to adolescence requires institutional responses that integrate care, support, and pedagogical organization sensitive to students’ emotional realities. Thus, understanding mental health as an inseparable part of the contemporary educational experience expands the role of the school beyond knowledge transmission, positioning it as an active agent in mitigating psychosocial risks and in building healthier, more humane, and more sustainable learning environments.

ACKNOWLEDGEMENT:

Funding: This work was supported by the National Council for Scientific and Technological Development (CNPq) – Research Productivity Scholarship – PQ.

Acknowledgments: The authors would like to thank the Center for Studies in Governance, Competitiveness, and Public Policies (GOVCOPP) at the University of Aveiro (UA), Portugal, and the “Organizations and Society” research laboratory at UTFPR - PG, Brazil.

Conflict of interest

The authors declare that they have no financial or non-financial conflicts of interest that could have influenced this research.

LITERATURE:

1. Aldridge, J. M., & McChesney, K. (2018). *The relationships between school climate and adolescent mental health and wellbeing: A systematic literature review*. International Journal of Educational Research, 88, 121-145.
2. American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. 5. ed. Arlington, VA: American Psychiatric Association.

3. American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders: DSM-5-TR*. Arlington, VA: American Psychiatric Association.
4. Antunes et al. (2022). *A saúde mental dos adolescentes brasileiros: Pesquisa Nacional de Saúde do Escolar de 2019*. REME-Revista Mineira de Enfermagem, 26.
5. Ariño, D. O., & Bardagi, M. P. (2018). *Relação entre fatores acadêmicos e a saúde mental de estudantes universitários*. Psicologia em pesquisa, 12(3), 44-52.
6. Baker, A. E., Galvan, A., & Fuligni, A. J. (2025). *The connecting brain in context: How adolescent plasticity supports learning and development*. Developmental Cognitive Neuroscience, 71, 101486.
7. Barlow, D. H. (2002). *Anxiety and its disorders: The nature and treatment of anxiety and panic*. 2. ed. New York: Guilford Press.
8. Branje, S., De Moor, E. L., Spitzer, J., & Becht, A. I. (2021). *Dynamics of identity development in adolescence: A decade in review*. Journal of Research on Adolescence, 31(4), 908-927.
9. Carranza, et al. (2024). *Associations between perceived parenting, brain activity and connectivity, and depression symptoms in Brazilian adolescents*. International journal of adolescence and youth, 29(1), 2354910.
10. Casey, B. J., Cohen, A. O., & Galvan, A. (2025). *The beautiful adolescent brain: An evolutionary developmental perspective*. Annals of the New York Academy of Sciences, 1546(1), 58-74.
11. Cavallari, J. M. et al. (2024). *Educator perspectives on stressors and health: a qualitative study of US K-12 educators in February 2022*. BMC Public Health, 24(1), 2733.
12. Collins, S. A. et al. (2024). *Barriers and facilitators to identifying depression in adolescents: A cross-cultural qualitative study in Brazil, Nepal, and Nigeria*. PLOS Mental Health, 1(7).
13. Crone, E. A., Green, K. H., van de Groep, I. H., & van der Crujisen, R. (2022). *A neurocognitive model of self-concept development in adolescence*. Annual Review of Developmental Psychology, 4, 273-295.
14. Daniélsdóttir, H. B. et al. (2024). *Adverse childhood experiences and adult mental health outcomes within sibships: A population-based cohort study*. JAMA Psychiatry, 81, 6, 586-594.
15. Dreer, B. (2023). *On the outcomes of teacher wellbeing: A systematic review of research*. Frontiers in psychology, 14, 1205179.
16. Fish, R. E. (2022). *Stratified medicalization of schooling difficulties*. Social Science & Medicine, 305, 115039.
17. Gratão, L. H. A. et al. (2024). *Common mental disorders in Brazilian adolescents: association with school characteristics, consumption of ultra-processed foods and waist-to-height ratio*. Cadernos de Saúde Pública, 40.
18. Graves, J. K., Hodge, C., & Jacob, E. (2016). *Depression, anxiety, and quality of life in children and adolescents with sickle cell disease*. Pediatric nursing, 42(3), 113.
19. Grazia, V., & Molinari, L. (2021). *School climate multidimensionality and measurement: A systematic literature review*. Research Papers in Education, 36(5), 561-587.
20. Juvonen, J., & Graham, S. (2014). *Bullying in schools: The power of bullies and the plight of victims*. Annual review of psychology, 65, 159-185.
21. Keyes, K. M., & Platt, J. M. (2024). *Annual Research Review: Sex, gender, and internalizing conditions among adolescents in the 21st century—trends, causes, consequences*. Journal of child psychology and psychiatry, 65(4), 384-407.

22. Letkiewicz, A. M., Li, L. Y., Hoffman, L. M., & Shankman, S. A. (2023). *A prospective study of the relative contribution of adolescent peer support quantity and quality to depressive symptoms*. *Journal of Child Psychology and Psychiatry*, 64(9).
23. Lima, A. F. B. D. S., & Fleck, M. P. D. A. (2010). *Qualidade de vida e depressão: uma revisão da literatura*. *Revista de Psiquiatria do Rio Grande do Sul*, 31.
24. Malta, D. C. et al. (2025). *Bullying practices by students aged 13 to 17 years according to the National Survey of School Health (2019)*. *Revista Brasileira de Epidemiologia*, 28.
25. Murray, A. L. et al. (2022). *Sex/gender differences in individual and joint trajectories of common mental health symptoms in early to middle adolescence*. *JCPP advances*, 2(1).
26. Nobre, M. R., & Freitas, L. C. (2021). *Habilidades sociais e ansiedade social na infância e adolescência: Revisão da literatura*. *Revista Psicologia: Teoria e Prática*, 23(2).
27. Nwoko, J. C. et al. (2023). *A systematic review of the factors that influence teachers' occupational wellbeing*. *International journal of environmental research and public health*, 20(12).
28. Odgers, C. L., & Jensen, M. R. (2020). *Annual research review: Adolescent mental health in the digital age: Facts, fears, and future directions*. *Journal of Child Psychology and Psychiatry*, 61(3), 336-348.
29. OECD. *PISA 2015 results (volume III): Students' well-being*. Paris: OECD Publishing, 2017.
30. OECD. *PISA 2018 results (volume III): What school life means for students' lives*. Paris: OECD Publishing, 2021.
31. Patton, G. C. et al. (2016). *Our future: a Lancet commission on adolescent health and wellbeing*. *The Lancet*, 387(10036), 2423-2478.
32. PNUD; IPEA; FJP. (2013). *Índice de Desenvolvimento Humano Municipal Brasileiro*. Brasília, DF: PNUD, Ipea, FJP, 2013.
33. Ravens-Sieberer, U. et al. (2014). *The European KIDSCREEN approach to measure quality of life and well-being in children: development, current application, and future advances*. *Quality of life research*, 23(3), 791-803.
34. Sala, A., Porcaro, L., & Gómez, E. (2024). *Social media use and adolescents' mental health and well-being: an umbrella review*. *Computers in Human Behavior Reports*, 14.
35. Steare, T., Muñoz, C. G., Sullivan, A., & Lewis, G. (2023). *The association between academic pressure and adolescent mental health problems: A systematic review*. *Journal of affective disorders*, 339, 302-317.
36. Tetteh-Quarshie, S., & Risher, M. L. (2023). *Adolescent brain maturation and the neuropathological effects of binge drinking: A critical review*. *Frontiers in neuroscience*, 16.
37. Thapa, A., Cohen, J., Guffey, S., & Higgins-D'Alessandro, A. (2013). *A review of school climate research*. *Review of educational research*, 83(3), 357-385.
38. Whoqol Group. (1998). *Development of the World Health Organization WHOQOL-BREF quality of life assessment*. *Psychological medicine*, 28(3), 551-558.
39. UNESCO. (2025). *What you need to know about mental health and psychosocial support in schools*. Paris: UNESCO.
40. Valkenburg, P., Beyens, I., Pouwels, J. L., van Driel, I. I., & Keijsers, L. (2021). *Social media use and adolescents' self-esteem: Heading for a person-specific media effects paradigm*. *Journal of communication*, 71(1), 56-78.
41. Valkenburg, P. M., Meier, A., & Beyens, I. (2022). *Social media use and its impact on adolescent mental health: An umbrella review of the evidence*. *Current opinion in psychology*, 44, 58-68.

42. Victo, E. R. D., Ferrari, G., Drenowatz, C., & Solé, D. (2024). *Associations of lifestyle behaviors with mental health in a nationwide cross-sectional survey of 152,860 Brazilian students*. *Revista Paulista de Pediatria*, 43.
43. Wendt, A. et al. (2023). *Health inequalities in Brazilian adolescents: Measuring and mapping gaps in a cross-sectional school-based survey*. *Health Science Reports*, 6(12).
44. World Health Organization. (2025). *Adolescent health*. Geneva: WHO.

FROM OVEREXPOSURE TO EXCLUSION: RETHINKING DIGITALISATION THROUGH AN INTERGENERATIONAL KNOWLEDGE MANAGEMENT LENS

Andrea Lelovics

*Bratislava University of Economics and Business, Slovakia
andrea.lelovics@euba.sk*

ABSTRACT

Digitalisation has transformed education systems and public service provision, yet its effects remain unevenly distributed across generations. This paper reframes polarised debates on digital technologies by conceptualising digital transformation as an intergenerational governance and knowledge management challenge. Drawing on international reports from the OECD, UNESCO, UNICEF, WHO, the European Commission, the ITU, the World Bank and the United Nations, it compares two structural patterns: overexposure and attention-related risks among youth, and digital exclusion and capability deficits among seniors. The analysis demonstrates that technology is neither inherently beneficial nor harmful; its societal impact depends on institutional design, pedagogical integration, competence development and rights-based safeguards. The paper proposes a life-course governance perspective in which proportional digital exposure and equitable access are calibrated to developmental and cognitive conditions. By shifting the focus from generational moral conflict to systemic institutional responsibility, it advances a balanced digitalisation framework grounded in proportionality, inclusion and adaptive public governance.

Keywords: *Digital competence, Digital exclusion, Intergenerational digital governance, Knowledge management*

1. INTRODUCTION

Digitalisation has become a defining structural force shaping education systems, public administration and social participation across the globe. International organisations consistently frame digital transformation as essential for economic competitiveness, social inclusion and sustainable development. At the same time, empirical evidence points to persistent inequalities and unintended consequences. Connectivity has expanded rapidly, yet divides remain structured by income, gender, geography and age. Within education, debates oscillate between enthusiasm for technological innovation and concern about distraction, declining attention and deteriorating learning outcomes. In parallel, older populations face increasing difficulty accessing essential services as public and financial systems migrate to digital platforms. These developments are frequently discussed in generational terms. Young people are portrayed as overexposed to screens, vulnerable to attention fragmentation and digital harm. Older adults are described as digitally excluded, lacking skills and facing barriers to participation. Such narratives often lead to moralised or polarised interpretations: either digital technologies are framed as inherently harmful to cognitive development, or they are presented as universally empowering tools whose benefits depend solely on access expansion. Both framings risk obscuring the institutional dimension of the problem. This paper proposes a systemic reframing. Rather than treating digitalisation as a generational conflict or a technological inevitability, it conceptualises digital transformation as a governance and knowledge management challenge unfolding across the life course. The core argument is that technology is neither inherently damaging nor inherently beneficial. Its effects depend on how exposure, access and competence are structured within educational and public systems. For younger cohorts, the governance issue concerns proportional exposure and pedagogical integration.

For older cohorts, it concerns equitable access, capability development and protection against exclusion. Across both groups, institutional design, data-informed policymaking and rights-based safeguards are critical. Drawing on international reports from the OECD, UNESCO, UNICEF, WHO, the European Commission, the World Bank, ITU and the United Nations, the paper synthesises evidence and policy principles relevant to what is termed intergenerational digital governance. By comparing findings on youth digital exposure and senior digital exclusion, it identifies a shared structural pattern: digital inequalities emerge when institutional arrangements fail to align technological integration with developmental, cognitive and social conditions. The research question guiding the analysis is twofold. First, to what extent can digitalisation debates be reframed from generational moral conflict to institutional knowledge design within globalised education systems? Second, what principles should guide intergenerational digital governance in order to ensure proportional digital exposure and equitable access across the life course?

Positioned within the subtopic of Education and Knowledge Management, the paper advances a conceptual contribution by articulating a life-course governance model. This model emphasises proportionality, competence development, multi-level coordination and data-driven oversight as core elements of balanced digitalisation. In doing so, it seeks to move beyond expansionist metrics of connectivity towards a governance framework capable of integrating quality, equity and developmental sensitivity in the digital transformation of education systems.

2. CONCEPTUAL FRAMING: INTERGENERATIONAL DIGITAL GOVERNANCE

Achieving equity of access and proportional exposure in the digital realm requires more than expanding infrastructure. The digital divide encompasses not only unequal access to devices and connectivity but also disparities in skills, competencies, and meaningful use (Avelar, 2025; Ferrante et al., 2024; Hébert et al., 2022; Iivari et al., 2020; Latuheru et al., 2024). The COVID-19 pandemic accelerated digital transformation while exposing these inequalities (Avelar, 2025; Ferrante et al., 2024; Iivari et al., 2020). National policies have prioritised infrastructure expansion, such as Brazil's ENEC and PIEC programmes (Avelar, 2025) and Argentina's "Conectar Igualdad" (Ferrante et al., 2024). Yet schools are central not only for access but for capability-building. Hébert et al. (2022) describe digital workshops for immigrant families; Iivari et al. (2020) report Finnish schools lending equipment; Akour and Alenezi (2022) advocate lifelong, flexible higher education models. Proportional exposure also requires inclusive participation. Passey (2014) highlights digital leader initiatives and a Computing Club for Girls to broaden engagement. Intergenerational learning in Suli Villages demonstrates reciprocal knowledge exchange, integrating digital literacy with local values (Latuheru et al., 2024). Collaborative parent-child learning further strengthens participation (Hébert et al., 2022). However, digitalisation also raises governance concerns. It may advance standardisation, homogenisation, and private sector influence (Avelar, 2025). Degen et al. (2025) and Kerssens and Dijck (2021) call for governance rooted in public interest to counter value capture by private actors. The Dutch Basispoort initiative illustrates interoperability under public control, aiming to prevent vendor lock-in and protect digital sovereignty (Kerssens & Dijck, 2021). Ferrante et al. (2024) warn against "solutionism" that assumes technology can resolve structural inequalities without addressing its risks. Governance is thus central to inclusive participation and intergenerational learning. Digital literacy policies seek to equip citizens for digitised societies (Ferrante et al., 2024; Gamliel & Gabay, 2014; Hébert et al., 2022; Iivari et al., 2020; Latuheru et al., 2024). Diverse governance levels – national, institutional, school-based, and community – shape outcomes (Akour & Alenezi, 2022; Degen et al., 2025; Gamliel & Gabay, 2014; Iivari et al., 2020; Latuheru et al., 2024; Passey, 2014).

The Israeli Multigenerational Connection Program exemplifies structured reciprocal learning between students and seniors (Gamliel & Gabay, 2014). Across cases, governance aims to empower actors, bridge generational gaps, and align digital competence with social cohesion (Hébert et al., 2022; Iivari et al., 2020; Latuheru et al., 2024). These governance arrangements also shape how digital systems structure exposure, participation, and vulnerability across generations. Data governance introduces further complexity. The datafication of education transforms policy and pedagogy through predictive analytics and “database government” (Williamson, 2016). Algorithmic systems risk narrowing opportunities and displacing professional judgement (Williamson, 2016), often without sufficient ethical scrutiny (Ferrante et al., 2024). Platformisation intensifies concerns about data extraction, privacy, and commercialization (Avelar, 2025; Degen et al., 2025; Kerssens & Dijck, 2021). National Digital Education Ecosystems and European initiatives aim to reconcile public values with technological integration through interoperability, data sovereignty, and regulatory coordination (Degen et al., 2025; Kerssens & Dijck, 2021). Overall, intergenerational digital governance requires a multi-layered approach addressing access, skills, participation, and ethical safeguards. It depends on collaborative networks – schools, families, communities, governments, and international organisations – balanced against commercial interests (Akour & Alenezi, 2022; Avelar, 2025; Degen et al., 2025; Ferrante et al., 2024; Hébert et al., 2022; Iivari et al., 2020; Kerssens & Dijck, 2021; Latuheru et al., 2024; Passey, 2014; Williamson, 2016). Digital transformation is therefore not merely technical, but institutional and normative, requiring proportional exposure, equitable capability-building, and sustained public oversight.

3. INTERGENERATIONAL DIGITAL GOVERNANCE: EVIDENCE AND PRINCIPLES FROM INTERNATIONAL REPORTS

This section synthesises evidence from major international organisations to examine digitalisation through an intergenerational lens. It compares findings on youth digital exposure and senior digital exclusion, and identifies cross-cutting governance principles emerging from global policy frameworks.

3.1. Youth, digital exposure, attention, and learning outcomes

International evidence suggests that the relationship between digital exposure and educational outcomes is neither linear nor uniformly positive. The OECD’s *Students, Computers and Learning* report concludes that students who use computers moderately at school tend to achieve somewhat better results than those who use them rarely, but students who use computers very frequently at school perform significantly worse in most learning domains, even after accounting for socio-economic background (OECD, 2015). The report further observes that high levels of investment in ICT have not translated into measurable improvements in student performance in reading, mathematics, or science across participating systems. This finding directly challenges technologically deterministic assumptions and indicates that intensity and pedagogical context matter. The most recent PISA 2022 results reinforce this complexity. OECD analyses report that students who are distracted by peers’ use of digital devices during lessons score lower in mathematics than those who are not distracted (OECD, 2023a). Moreover, frequent use of digital devices for certain school-related activities is not consistently associated with improved academic performance, suggesting that the educational value of technology depends on structured and purposeful integration rather than exposure alone (OECD, 2023b). These findings shift attention from access provision to classroom governance, instructional design, and the regulation of device use. UNESCO’s *Global Education Monitoring Report 2023* similarly cautions against uncritical adoption of technology in education systems. It emphasises that technology should support, not replace, teacher-led instruction and warns that rapid digital expansion without adequate

pedagogical planning can undermine equity and quality (GEM Report UNESCO, 2023). The report calls for decisions about technology use to be guided by educational objectives rather than commercial or technological pressures. This framing reinforces the need for governance principles rooted in proportionality. UNICEF's *State of the World's Children 2017* highlights both opportunities and risks of digital engagement for children and adolescents. While digital tools can expand access to information, learning resources, and participation, unequal access and inadequate skills can reinforce existing social inequalities (UNICEF, 2017). The report also notes risks related to exposure to harmful content, cyberbullying, and privacy concerns, underscoring the importance of protective frameworks and digital literacy. These concerns situate digital exposure within broader developmental and safeguarding contexts. WHO's fact sheets on adolescent mental health indicate that adolescence is a critical developmental period during which social, emotional, and behavioural patterns are established, and that mental health conditions account for a significant share of disease burden among young people (WHO, 2025). Although WHO does not attribute mental health trends solely to digital media, it recognises that online environments can influence well-being, including through risks such as cyberbullying and social pressure. This reinforces the governance relevance of attention, psychosocial safety, and moderated exposure. At the policy level, the European Commission's *Digital Education Action Plan (2021–2027)* frames digital transformation as a systemic priority, aiming to foster high-performing digital education ecosystems and enhance digital skills and competences for all learners (European Commission, n.d.-b). However, it emphasises the development of digital capacity and teacher training rather than mere device deployment. Complementing this, the Joint Research Centre's *DigComp 2.2* defines digital competence as a combination of knowledge, skills, and attitudes across domains such as information literacy, communication, safety, and problem-solving (European Commission. Joint Research Centre., 2022). This competence-based approach implies that effective digitalisation depends on structured capability development across life stages rather than intensity of use. Taken together, these international reports converge on a common principle: youth digital exposure should be proportionate, pedagogically grounded, and supported by competence development. Excessive or poorly governed use may undermine attention and learning outcomes (OECD, 2015, 2023a), while insufficient literacy and safeguards may expose young people to risks (UNICEF, 2017; WHO, 2025). Policy frameworks increasingly recognise that digital transformation in education must prioritise quality, equity, and structured competence formation over technological expansion alone (European Commission, n.d.-b; European Commission. Joint Research Centre., 2022; GEM Report UNESCO, 2023).

3.2. Seniors, digital exclusion, and financial vulnerability

International evidence indicates that digital transformation has not been evenly distributed across age groups, with older adults consistently reporting lower levels of digital skills and digital service use. The Digital Economy and Society Index (DESI) indicators show persistent disparities in digital public service use and digital skills among older populations compared to younger cohorts across EU Member States (European Commission, n.d.-a). These differences are reflected in composite measures of digital skills and e-government use, where older age groups remain underrepresented among users with at least basic digital competences. Eurostat's Digital Skills Indicator by age group further confirms that individuals aged 55–74 are significantly less likely to possess at least basic overall digital skills compared to younger age groups, and are more frequently represented among those with low or no digital skills (EUROSTAT, 2026). This age gradient in digital competence illustrates that digital exclusion is not only a matter of connectivity, but also of capability. Since digital skills increasingly mediate access to banking, public administration, and health services, such disparities have direct implications for financial and social participation.

The World Health Organization's *Global Strategy and Action Plan on Ageing and Health* recognises that population ageing is occurring alongside rapid technological change and emphasises the importance of ensuring that health and social systems remain accessible to older adults (World Health Organization, 2017). Although not focused exclusively on digital technologies, the strategy underlines the need for age-friendly environments and equitable access to services, which in digitalised systems increasingly requires digital competence and inclusive design. Without deliberate policy intervention, technological shifts risk reinforcing functional limitations and barriers faced by older populations.

The World Bank's *World Development Report 2021: Data for Better Lives* situates these disparities within a broader governance context. It argues that data and digital systems generate value only when supported by institutions that protect inclusion, trust, and equitable access (World Bank, 2021). The report stresses that digital transformation must be accompanied by safeguards that prevent exclusion and ensure that benefits are widely shared, particularly among vulnerable groups. In the absence of such institutional arrangements, digitalisation can amplify existing inequalities rather than reduce them.

Taken together, these sources converge on a structural pattern: older adults are disproportionately affected by deficits in digital skills and digital service use (European Commission, n.d.-a; EUROSTAT, 2026), while ageing strategies and global data governance frameworks acknowledge the need for inclusive, accessible systems (World Bank, 2021; World Health Organization, 2017). This combination of empirical disparity and governance recognition supports the interpretation of senior digital exclusion as an institutional design challenge rather than an individual deficit. In increasingly digital public and financial ecosystems, insufficient digital competence may translate into reduced access to services, diminished autonomy, and heightened vulnerability.

3.3. Cross-cutting governance and knowledge management

Across international policy documents, digital governance is framed not only as a technical matter of infrastructure deployment, but as a systemic knowledge management challenge involving coordination, standards, institutional capacity, and value alignment. The United Nations' policy brief *A Global Digital Compact – an Open, Free and Secure Digital Future for All* identifies persistent digital, data and innovation divides despite growth in connectivity, noting that 5.3 billion people are online while divides persist across regions, income, gender and age (United Nations, 2023). It emphasises that the digital divide is accompanied by a “massive governance gap”, where technological development outpaces regulatory and institutional capacity, and public administrations are often under-equipped to respond. The proposed Global Digital Compact is therefore conceived as a multi-stakeholder framework to articulate shared principles, measurable objectives and coordinated action across domains including connectivity, data governance, human rights, trust and security. Importantly, it calls for common frameworks and standards for digital public infrastructure, interoperability, pooled data resources and strengthened public-sector capacities, situating governance as a knowledge orchestration task rather than merely a regulatory function. The *Measuring Digital Development: Facts and Figures 2025* report by the International Telecommunication Union (ITU) provides the empirical basis for such governance efforts. In 2025, 74 per cent of the global population were online, yet 2.2 billion people remained offline, with connectivity strongly correlated with income level (*Measuring Digital Development Facts and Figures 2025*, 2025). High-income countries approach universal use (94 per cent), whereas only 23 per cent of the population in low-income countries use the Internet.

Gender gaps persist globally (77 per cent of men versus 71 per cent of women online; gender parity score 0.92). Youth Internet use (82 per cent among 15–24-year-olds) exceeds that of the rest of the population (72 per cent), although the gap is narrowing. These data illustrate that digital governance must be grounded in systematic measurement and disaggregated monitoring, as inclusion patterns differ across age, gender, geography and income. Knowledge management, in this sense, involves continuous data collection, benchmarking and policy feedback loops. At the European level, the *European Declaration on Digital Rights and Principles for the Digital Decade* articulates a normative governance framework grounded in fundamental rights. It affirms that what is illegal offline is illegal online and that the digital transformation should not entail regression of rights (European Commission, 2023). The Declaration emphasises universal access to affordable, high-speed connectivity, digital education and lifelong learning, fair working conditions in the digital environment, transparency and human oversight in algorithmic systems, and privacy and data protection. It also stresses solidarity and inclusion, explicitly referencing elderly people, rural populations and other vulnerable groups as beneficiaries of a digital transformation that leaves no one behind. The document has a declaratory nature but is intended to guide policymakers and serve as a reference point for businesses and other actors in developing and deploying technologies.

Taken together, these documents converge on several cross-cutting governance principles relevant to intergenerational digital governance. First, digital transformation requires measurable targets and data-informed policy (*Measuring Digital Development Facts and Figures 2025*, 2025; United Nations, 2023). Second, governance must be multi-level and multi-stakeholder, combining Member States, multilateral organisations, private actors and civil society in coordinated frameworks (United Nations, 2023). Third, digital rights and inclusion are not peripheral concerns but constitutive principles, encompassing connectivity, skills, privacy, safety and algorithmic transparency (European Commission, 2023). Finally, institutional capacity-building – particularly within public administration – is repeatedly identified as essential to prevent governance gaps and ensure that digitalisation advances sustainable development and human well-being rather than exacerbating divides (United Nations, 2023). In knowledge management terms, these sources collectively frame digital governance as the design of interoperable infrastructures, shared standards, transparent data ecosystems and rights-based institutional arrangements that enable continuous learning and adaptive policy across generations.

4. CONCLUSION

The comparative analysis of international reports demonstrates that digitalisation generates distinct but structurally related governance challenges across the life course. For younger generations, the central risk is not lack of access but unregulated or excessive exposure. Evidence from OECD, UNESCO, UNICEF and WHO indicates that high-intensity or poorly structured digital use may undermine attention, learning outcomes and psychosocial well-being, whereas competence-based, pedagogically grounded integration can support educational development. The policy implication is not technological retrenchment but proportionality: exposure must be aligned with developmental conditions, instructional design and safeguarded learning environments. For older generations, the dominant challenge is not overexposure but exclusion. DESI, Eurostat and WHO data show persistent age gradients in digital skills and service use, while global governance frameworks recognise that insufficient digital capability may restrict access to essential services, financial systems and health infrastructures. In increasingly digital public ecosystems, capability gaps translate into vulnerability.

The governance problem is therefore systemic: without inclusive design, targeted competence-building and institutional safeguards, digitalisation risks amplifying rather than mitigating inequality. Across both groups, international frameworks converge on a shared principle: digital transformation is not inherently beneficial or harmful; its societal effects depend on institutional design. The United Nations' Global Digital Compact, ITU monitoring frameworks and the European Declaration on Digital Rights and Principles collectively position digital governance as a multi-level, data-informed and rights-based endeavour. Infrastructure deployment, competence development, privacy protection, algorithmic transparency and public-sector capacity-building are not discrete policy fields but interdependent components of a coherent governance architecture. The intergenerational perspective advanced in this paper reframes polarised debates between techno-optimism and moral panic into a question of proportional governance across the life course. Balanced digitalisation requires differentiated strategies: moderated and pedagogically structured exposure for youth; accessible, competence-enhancing and inclusive systems for seniors; and cross-cutting institutional mechanisms that ensure transparency, interoperability and rights protection. In this sense, intergenerational digital governance is best understood as a knowledge management task: designing adaptive institutions capable of calibrating exposure and access according to developmental, cognitive and social conditions. Such a reframing shifts the analytical focus from generational blame to systemic responsibility. Digital equity, attention protection and inclusion are not matters of individual discipline alone but outcomes of regulatory design, public investment and coordinated international frameworks. The challenge for education systems and public administrations is therefore to move beyond expansionist metrics of connectivity and towards governance models that integrate proportional exposure, equitable access and competence formation throughout the life course.

ACKNOWLEDGEMENT: *This paper is the output of the research grant VEGA No. 1/0226/23 “Socio-economic challenges and opportunities related to aging policy to ensure sustainable economic growth and innovation”.*

LITERATURE:

1. Akour, M., & Alenezi, M. (2022). Higher Education Future in the Era of Digital Transformation. *Education Sciences*, 12(11), 784. <https://doi.org/10.3390/educsci12110784>
2. Avelar, M. (2025). Mapping the digital education landscape: Stakeholders and networks of governance in Brazil. *International Journal of Educational Development*, 112, 103192. <https://doi.org/10.1016/j.ijedudev.2024.103192>
3. Degen, K., Lutzens, R., Beschorner, P., & Lucke, U. (2025). Public education data at the crossroads of public and private value creation: Orchestration tensions and stakeholder visions in Germany's emerging national digital education ecosystem. *Electronic Markets*, 35(1), 19. <https://doi.org/10.1007/s12525-024-00752-w>
4. European Commission. (n.d.-a). DESI indicators [Data set]. Retrieved 15 February 2026, from https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi/charts/desi-indicators?period=desi_2025&indicator=desi_us&breakdown=total&unit=egov_score&country=AT,BE,BG,HR,CY,CZ,DK,EE,EU,FI,FR,DE,EL,HU,IE,IT,LV,LT,LU,MT,NL,PL,PT,RO,SK,SI,ES,SE
5. European Commission. (n.d.-b). Digital Education Action Plan: Policy background. European Education Area. Retrieved 15 February 2026, from <https://education.ec.europa.eu/focus-topics/digital-education/plan>
6. European Commission. (2023, January 23). European Declaration on Digital Rights and Principles for the Digital Decade (2023/C 23/01). *Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOC_2023_023_R_0001

7. European Commission. Joint Research Centre. (2022). DigComp 2.2, The Digital Competence framework for citizens: With new examples of knowledge, skills and attitudes. Publications Office. <https://doi.org/10.2760/115376>
8. EUROSTAT. (2026, January). Skills for the digital age. <https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=628712>
9. Ferrante, P., Williams, F., Büchner, F., Kiesewetter, S., Chitsauko Muyambi, G., Uleanya, C., & Utterberg Modén, M. (2024). In/equalities in digital education policy – sociotechnical imaginaries from three world regions. *Learning, Media and Technology*, 49(1), 122–132. <https://doi.org/10.1080/17439884.2023.2237870>
10. Gamliel, T., & Gabay, N. (2014). Knowledge Exchange, Social Interactions, and Empowerment in an Intergenerational Technology Program at School. *Educational Gerontology*, 40(8), 597–617. <https://doi.org/10.1080/03601277.2013.863097>
11. GEM Report UNESCO. (2023). Global Education Monitoring Report 2023: Technology in education: A tool on whose terms? (1st edn). GEM Report UNESCO. <https://doi.org/10.54676/UZQV8501>
12. Hébert, C., Thumlert, K., & Jenson, J. (2022). #Digital parents: Intergenerational learning through a digital literacy workshop. *Journal of Research on Technology in Education*, 54(1), 34–91. <https://doi.org/10.1080/15391523.2020.1809034>
13. Iivari, N., Sharma, S., & Ventä-Olkkonen, L. (2020). Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *Impact of COVID-19 Pandemic on Information Management Research and Practice: Editorial Perspectives*, 55, 102183. <https://doi.org/10.1016/j.ijinfomgt.2020.102183>
14. Kerssens, N., & Dijck, J. van. (2021). The platformization of primary education in The Netherlands. *Learning, Media and Technology*, 46(3), 250–263. <https://doi.org/10.1080/17439884.2021.1876725>
15. Latuheru, M. S., Manuputty, F., & Sulaiman Angkotasari. (2024). Interactions Between Generations in Digital Literacy Education: A Case of Millennial Families in Suli, Central Maluku. *Baileo: Jurnal Sosial Humaniora*, 1(2). <https://doi.org/10.30598/baileofisipvol1iss2pp141-154>
16. Measuring digital development Facts and Figures 2025. (2025). ITU Publications.
17. OECD. (2015). *Students, Computers and Learning: Making the Connection*. OECD. <https://doi.org/10.1787/9789264239555-en>
18. OECD. (2023a). PISA 2022 Results (Volume I): The State of Learning and Equity in Education. OECD Publishing. <https://doi.org/10.1787/53f23881-en>
19. OECD. (2023b). PISA 2022 Results (Volume II): Learning During – and From – Disruption. OECD Publishing. <https://doi.org/10.1787/a97db61c-en>
20. Passey, D. (2014). Intergenerational learning practices—Digital leaders in schools. *Education and Information Technologies*, 19(3), 473–494. <https://doi.org/10.1007/s10639-014-9322-z>
21. UNICEF (Ed.). (2017). *Children in a digital world*. UNICEF.
22. United Nations. (2023). *A Global Digital Compact—An Open, Free and Secure Digital Future for All (Our Common Agenda Policy Brief 5)*. <https://www.un.org/sites/un2.un.org/files/our-common-agenda-policy-brief-gobal-digi-compact-en.pdf>
23. WHO. (2025, September 1). Mental health of adolescents. *Health Topics*. <https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health>
24. Williamson, B. (2016). Digital education governance: An introduction. *European Educational Research Journal*, 15, 13–13. <https://doi.org/10.1177/1474904115616630>
25. World Bank. (2021). *World Development Report 2021: Data for Better Lives*. Washington, DC: World Bank. <https://doi.org/10.1596/978-1-4648-1600-0>
26. World Health Organization. (2017). *Global strategy and action plan on ageing and health*.

ENHANCING DIGITAL MATURITY IN CROATIAN HIGHER EDUCATION: RECOMMENDATIONS BASED ON EUROPEAN BEST PRACTICES

Dana Dobric Jambrovic

University of Rijeka, Faculty of Law

Hahlić 6, 51000 Rijeka, Croatia

dana.dobric@uniri.hr

ABSTRACT

Digital transformation of higher education constitutes a dominant paradigm shift in contemporary society, wherein traditional pedagogical models are integrated with advanced technologies such as artificial intelligence, learning management systems, and adaptive learning platforms. The COVID-19 pandemic has accelerated this process, compelling institutions to rapidly transition to hybrid and online modalities, thereby underscoring the imperative for digital competencies among faculty and students. Nevertheless, this transformation presents challenges including the digital divide and resistance to change, alongside opportunities for personalized, inclusive, student-centered learning tailored to 21st-century demands. Following the introduction and theoretical framework, the author will present the state of the art in higher education digitalization in the Republic of Croatia. Particular attention will be devoted to deficiencies in the regulatory framework governing the modalities of artificial intelligence implementation. Therefore, the objective of this paper is to examine the achievements of digitalization in higher education through an analysis of best practices in European countries, as well as the solutions adopted by national systems to address the technical, organizational, pedagogical, and social challenges inherent in this process. The research will employ a comparative method and desk review of legal frameworks and strategic documents from selected countries, the synthesis of best practices, and a constructive approach to formulate recommendations for the optimal integration of ICT tools in learning and teaching within higher education. As a final outcome of the research, these recommendations may serve Croatian and other national higher education systems in adapting and enhancing measures for their digital transformation.

Keywords: *comparative analysis, Croatia, digital transformation, higher education, student-centered learning*

1. INTRODUCTION

Today's social changes are largely driven by the processes of globalization and technological development, which is specifically reflected in public governance. New paradigms emerging from technological and social advancements—stemming from the mass use of information and communication technologies (ICT)—generate a transformational process that modifies all sectors, including education. Higher education constitutes a complex system of vertically and horizontally differentiated institutions that provide education and training at the post-secondary level. In addition to transferring the knowledge and skills essential for professional and social engagement, higher education institutions (HEIs) provide a wide range of services to their communities (Shuetze, de Vries, Mendiola, 2024, p.7). There are three historical moments or phases of ICT integration into the higher education environment. The first phase was marked by the mass application of computers in accounting and the automation of office activities. The second phase refers to the development of highly specialized software solutions and their widespread use in nearly all other academic activities, while the third phase is characterized by the extensive use of communication software and learning management systems (Casillas Alvarado, Ramirez Martinell, Rozenbraver Lopez, 2024, p.137).

The integration of ICT into higher education was gradual and did not occur based on systematic needs assessment, long-term planning, or a strategic approach. The United Kingdom, Germany, Canada, Brazil, South Korea, and Japan were among the first countries to develop 'open universities', which provided education through the delivery of printed teaching materials and the establishment of communication channels between students and teachers, often via radio waves. Digitalization replaced printed materials with learning software, websites, and electronic libraries, and telephone communication with online channels and virtual classrooms. Furthermore, online education gained widespread recognition with the emergence of Massive Open Online Courses (MOOCs) in the mid-2010s, offered to a broader audience by a few American universities. Another model of online distance learning outside traditional institutions is the Open Educational Resources (OER) system—courses and materials made publicly available by various organizations through the waiver of copyright (Levin, 2024, p. 264). This is particularly important for the growing group of 'lifelong learners' who, often in later stages of life, choose to upgrade their professional qualifications or satisfy personal learning needs. Many traditional campus-based higher education institutions have incorporated online elements into their curriculum, offering a combination of classroom instruction and digital learning, namely hybrid and blended learning. Finally, in the recent period, the digitalization of higher education was spurred and accelerated by the COVID-19 pandemic, enabling a more systematic process of institutional and systemic planning and implementation. Higher education has traditionally been organized through lectures, seminars, classroom discussions, and laboratory work, while student learning typically involved a combination of classroom experience, individual mentorship, dialogue with instructors and tutors, and independent study, primarily from academic literature such as books and journals. Digitalization is shifting this paradigm: online teaching and learning are replacing, augmenting, and partially substituting traditional forms of knowledge transfer and acquisition. Online courses and self-study enable both asynchronous and synchronous instructional activities. Online learning supported by ICT—particularly learning platforms and Learning Management Systems (LMS)—has rendered teaching and learning independent of time and space constraints. Although learning is not exclusively an individual activity, online learning benefits students by allowing for individual pacing and personalized feedback and support from instructors (Schuetze, de Vries, Mendiola, *op. cit.*). The pandemic accelerated and deepened the digitalization of all aspects of teaching and learning, especially course design, instructional methods, assessment, learning analytics, and the issuance of credentials. There is a growing student demand for more flexible study options; besides online learning, this includes part-time studies, blended learning formats, and alternative qualifications such as certificate programs and micro-credentials. However, online and blended programs are not universally applicable to all types of study programs or student categories. They are better suited for motivated students with a high capacity for independent learning and initiative, while online studies are less suitable for non-traditional students (OECD, 2021, p. 40). Furthermore, they are not appropriate for study programs with significant practical components, such as medicine or engineering. It remains necessary to monitor student needs and interests while continuing to develop higher education toward student-centered learning and flipped classrooms. The era of digital intelligence marks a phase in which society gradually integrates computerization and digitalization, driven by key technologies such as Big Data, cloud computing, Artificial Intelligence (AI), the Internet of Things (IoT), and blockchain. These technologies, encompassing both digital and intelligent innovations, have already been widely adopted and are significantly reshaping social processes within the current technological revolution. In this context, it is crucial to emphasize that the digital transformation of higher education requires an increased focus on legal frameworks, as well as the integration of legal reasoning and methodologies into the entire educational governance process and all aspects of university administration (Liu, 2025, p. 388).

This paper aims to explore the state of the art of digital transformation in Croatian higher education and, based on the research findings, formulate recommendations for the future course of this transformation. First, the national legal framework and strategic documents supporting digitalization were analyzed. This was followed by research conducted across all Croatian universities regarding the implemented measures of digital transformation. Subsequently, the best practices of leading European countries in digital transformation were analyzed and described to shape policy recommendations for the further improvement of the Croatian higher education system.

2. ANALYSIS OF DIGITAL MATURITY OF THE HIGHER EDUCATION SYSTEM IN CROATIA

The digitalization process of the Croatian public administration, including the higher education system, is expectedly evolving in line with general societal development. Following the priorities of the European Union, which in 2021 adopted the '2030 Digital Compass: the European Way for the Digital Decade',¹ the Croatian legislator adopted the 'Strategy for Digital Croatia for the period until 2032' at the end of 2022.² The adoption of this Strategy represents the fulfillment of one of the objectives of the National Recovery and Resilience Plan (NRRP)³ and serves as a strategic planning act supporting the implementation of the 'National Development Strategy of the Republic of Croatia until 2030', which provides long-term direction for societal and economic development across all key areas.⁴ Following an analysis of the state of digitalization in Croatian society, four strategic goals were identified for further development, two of which include measures for the transformation of the higher education system: the digitalization of public administration and the development of digital competencies and digital jobs.⁵

Within these goals, priority areas for public policy implementation have been elaborated. Those relevant to higher education include increasing the number of ICT experts in the labor market, developing citizens' digital competencies for living and working with ICT, and the digital transition as a support for the development of the educational and research system. Some of the specific measures envisioned include investments in digital teaching infrastructure, digital teaching tools, and the strengthening of teachers' competencies for instruction in a digital environment.

Efforts will also be made to improve higher education administration with the aim of eliminating challenges posed by the current siloed structure of solutions and data fragmentation. Furthermore, the development of open digital learning resources will be encouraged, alongside the procurement of active equipment and the enhancement of passive network infrastructure to support new technologies and digital educational resources. Additionally, improved and more stimulating conditions for researchers' career development will be ensured. Various institutions are involved in shaping the digital transformation policy of higher education.

¹ EC, COM(2021) 118 final, 9.3.2021. It is also important to highlight the Digital Education Action Plan (2021-2027) as a European Commission policy initiative that sets out a common vision of high-quality, inclusive, and accessible digital education in Europe. It aims to help national education and training systems adapt to the digital age.

² Digital Croatia Strategy until 2032, Official Gazette no. 2/23

³ Government of the Republic of Croatia. (2021). National Recovery and Resilience Plan 2021-2026, component 3.2. Digital Transformation of Society and Economy, pp. 40-41

⁴ National Development Strategy of the Republic of Croatia until 2030, Official Gazette no. 13/21

⁵ The remaining two areas are the digital transition of the economy and the development of broadband electronic communication networks.

At the national level, these include the Ministry of Science, Education and Youth, the Central State Office for the Development of the Digital Society, the National Council for Higher Education, Science and Technological Development, the Strategic Committee for Research Infrastructure, the Agency for Science and Higher Education, committees for the popularization of science, scientific publishing, and scientific conferences and associations, as well as the Rectors' Conference of the Republic of Croatia. Naturally, universities and HEIs also adopt strategic documents in this field autonomously, yet in alignment with European and national priorities. The legal regulations adopted so far as instruments for advancing digital transformation regulate the fields of higher education and scientific activity, the Croatian Qualifications Framework (CROQF), the content and use of information systems in higher education, the conditions for student meal subsidies, student identification documents, and the authentication and authorization infrastructure (AAI@EduHr) of science and higher education, among others.⁶ In these areas, a series of e-services has been developed (Bedeković, Grubišić, 2024, pp. 120-122) regarding: the National Information System for Applications to Higher Education Institutions (NISpVU), the Information System of Higher Education Institutions (ISVU), the Information System of Student Rights (ISSP), the Information System of Academic Cards (ISAK), the Digital Diploma Register (ISeVO), State scholarships in STEM fields, the scientist identification number search engine, the Portal of Croatian Scientific and Professional Journals (HRČAK), advanced computing and storage resources, and virtual data centers (HR-ZOO/HR-ZOO).

The conducted research encompassed ten Croatian public and four private universities.⁷ A desk review was performed on the strategic documents and academic regulations (ordinances on studies and studying) adopted and publicly disclosed by these institutions on their official websites. The analysis revealed that all Croatian universities participate in digital transformation through their activities, which can be grouped as follows: (a) the adoption of strategic documents planning for digital development; (b) the enactment of academic regulations governing distance or hybrid learning; (c) the integration of ICT into teaching and business processes; (d) the accreditation of online study programs; (e) the development of digital infrastructure; and (f) teacher training aimed at strengthening their digital competencies. Regarding the adoption of strategic documents, only one public university has adopted strategic guidelines for digital transformation,⁸ while the remaining universities have integrated digital transformation into their core development documents, such as research strategies, quality policies, and multi-annual development strategies. On the other hand, concerning subordinate legislation (by-laws), all universities have prescribed the possibility of online and hybrid teaching, with variations in the regulation of instructional methods and student assessment.

⁶ Act on Higher Education and Scientific Activity, Official Gazette No. 119/22, Act on the Croatian Qualifications Framework, Official Gazette Nos. 22/13, 41/16, 64/18, 47/20, 20/21, Ordinance on the Content and Use of Information Systems in Higher Education, Official Gazette No. 36/23, Ordinance on the Conditions and Manner of Exercising the Right to Student Meal Subsidies, Official Gazette No. 120/13, Ordinance on Student Identification Documents, Official Gazette No. 101/23, Ordinance on the Organization of the Authentication and Authorization Infrastructure of Science and Higher Education in the Republic of Croatia – AAI@EduHr, retrieved 17.2.2026. from <https://wiki.srce.hr/spaces/AAIUPUTE/pages/65405172/Dokumenti?preview=/65405172/65405186/AAI%40EduHr-pravilnik-ver1.3.1.pdf>

⁷ Public universities in Dubrovnik, Koprivnica, Osijek, Pula, Rijeka, Slavonski Brod, Split, Zadar, and Zagreb, as well as the private universities Algebra, Libertas, Vern, and the Catholic University of Croatia.

⁸ University of Zagreb. (2024). Strategic Guidelines for the Digital Transformation of the University of Zagreb until 2032. Retrieved 18.2.2026. from https://www.unizg.hr/fileadmin/rektorat/O_Sveucilistu/Dokumenti_javnost/Dokumenti/Strateski_dokumenti/Strateske_smjernice_digitalne_transformacije_UniZG_210x280_mm_11_10_24.pdf

In this context, examples of best practices include multimedia interactive educational materials (OER), the flipped classroom model which places students at the center of the educational process, the use of web portals for the dissemination of educational materials, and interactive systems for assessment and self-assessment. Furthermore, this includes complex LMS and systems for building and supporting virtual learning environments (VLE), as well as access to educational content repositories, digital libraries, archives, and museums, and the facilitation of collaborative learning and the acquisition of project and team-based work skills. HyFlex courses have also begun to be introduced, meaning they are prepared and delivered simultaneously in the classroom, synchronously online, or made available asynchronously, allowing students to change their mode of attendance on a daily basis (Kučina Softić, Odak, Lasić Lazić, 2021, p. 67). The digitalization of business processes at Croatian universities is carried out through the integration of several key national information systems that automate administration, teaching, and student rights, such as the previously mentioned ISVU, ISeVO, and ISSP systems. Additionally, universities have integrated information systems for financial and accounting management, time and attendance tracking, and the monitoring of academic promotions. According to the Register of Study Programs, only ten study programs are delivered online at three public universities, with an additional ten at one private university, accounting for a negligible 1.1% of the total number of accredited study programs.⁹

Within the framework of the national strategic project e-University, which aims for the comprehensive digital transformation of higher education,¹⁰ all universities are investing in infrastructure modernization and empowering teachers to create digital educational content and apply modern teaching methods. The development of digital infrastructure includes ensuring high-speed and stable internet connectivity, cybersecurity, establishing data centers, and equipping classrooms for hybrid learning. Finally, all Croatian universities provide faculty members with digital competency training through in-house and external workshops, as well as online courses. At the national level, the University Computing Centre (SRCE)¹¹ and the Croatian Academic and Research Network (CARNET)¹² offer training programs in multimedia content creation, cybersecurity, the use of learning management systems, collaboration and communication tools, and interactive teaching tools. These programs are intended not only for teaching and professional staff but also for students. Lastly, it is crucial to specifically address Artificial Intelligence (AI), which currently serves as the primary driver of digital transformation. To date, no Croatian university has adopted a formal ordinance to regulate the use of AI in the instructional process. Two universities have recently issued guidelines or policies for the responsible use of AI tools,¹³ while others confirm they are in the phase of intensive work on drafting such frameworks.

⁹ Data from the Register of Study Programs of the Ministry of Science, Education and Youth as of February 23, 2026.

¹⁰ e-Sveučilišta. Retrieved 18.2.2026. from <https://www.carnet.hr/projekt/e-sveucilista/>

¹¹ SRCE. Retrieved 15.2.2026. from <https://www.srce.unizg.hr/>

¹² CARNET. Retrieved 15.2.2026. from <https://www.carnet.hr/>

¹³ University North. (2025). Guidelines for the Responsible Use of AI Tools. Retrieved 19.2.2026. from [/https://www.unin.hr/wp-content/uploads/Uz-Pravilnik-o-zavr%C5%A1nim-radovima_Smjernice-za-odgovornost-kori%C5%A1tenje-AI-alata_SS.pdf](https://www.unin.hr/wp-content/uploads/Uz-Pravilnik-o-zavr%C5%A1nim-radovima_Smjernice-za-odgovornost-kori%C5%A1tenje-AI-alata_SS.pdf)

University of Rijeka. (2024). AI Usage Policy at the University of Rijeka. Retrieved 19.2.2026. from https://uniri.hr/wp-content/uploads/2025/12/2024_01_23_Politika_koristenja_alata_UI-a-1.pdf

University of Rijeka. (2025). Guidelines for the Responsible Use of Artificial Intelligence Tools at the University of Rijeka. Retrieved 19.2.2026. from

file:///D:/Users/Korisnik/Downloads/2025_12_16_Smjernice_za_odgovorno_koristenje_alata_UI-a-1.pdf

3. BEST PRACTICE EXAMPLES IN THE DIGITAL TRANSFORMATION OF HIGHER EDUCATION: FINLAND AND ESTONIA

An analysis of the higher education systems of selected European countries (Finland, Denmark, the Netherlands, Sweden, and Estonia)¹⁴ revealed an enviable level of digital maturity, with Finland and Estonia clearly leading the way. Therefore, due to the limited scope of this paper, the best practices of these two countries will be presented. Finland is considered one of the global leaders in the digitalization of education, thanks to the strategic integration of technology, pedagogy, and administrative efficiency. In 2021, the Ministry of Education and Culture launched the implementation of the Digivisio 2030 program, intended for all higher education institutions.¹⁵ Beyond upgrading digital infrastructure and implementing e-learning tools, Finland has most systematically developed a pedagogical approach based on data, namely Data-Driven Pedagogy. Simply put, this approach adapts instruction to the actual needs of students in real-time. Instead of relying solely on feedback provided after the semester concludes, the Finnish system utilizes data generated during the learning process itself. It is based on the systematic collection, analysis, and interpretation of the digital footprints that students leave within LMS. Consequently, it represents a shift from traditional, reactive teaching models toward proactive and personalized educational strategies, integrating Learning Analytics and Artificial Intelligence into the very core of the curriculum (Dixon, Howe, Richter, 2025). The methodological framework of this approach is based on multimodal data collection. The primary methodology includes log-file analysis, which records student interactions with digital content. According to the model applied by the Finnish project AnalytiikkaÄly (Teräs, M. et al., 2020, pp. 455-463), data are categorized into three key dimensions: temporal (access time and session duration), interactional (participation in forums and collaborative tools), and performance-based (results from quizzes and automated assignments). The foundation of data processing is predictive modeling—a statistical technique that uses historical data and machine learning algorithms to predict future student outcomes or behaviors with a certain degree of probability (Ouatik, F. et al., 2022, p. 24). Finnish researchers from the University of Turku developed the VILLE platform, which utilizes an Immediate Feedback Loop methodology: based on real-time error data, students are offered alternative resources, thereby creating a personalized learning path. Data serve as a diagnostic tool that guides instructors toward parts of the curriculum that students perceive as most challenging, allowing them to adjust the Learning Design on the fly. Ultimately, this approach fosters Self-Regulated Learning (SRL). Through the use of digital dashboards, students gain direct insight into their own progress. The visualization of achievement data compared to set course goals functions metacognitively, encouraging students to reflect on their learning strategies and take greater responsibility for their educational outcomes.¹⁶ Such an elaborated pedagogical approach, encompassing the entire teaching cycle, represents the best example of student-centered education. On the other hand, Estonia stands out as a leader in integrating generative artificial intelligence into all levels of the pedagogical process. Unlike previous initiatives focused on infrastructure and digital literacy (Aru-Chabilan, 2020, pp. 61-72), the 'AI Leap' program, launched in 2025, focuses on developing AI literacy and redefining cognitive learning processes (Scarito, 2026). It is based on three main pillars aimed at ensuring that technology serves as a support for human reasoning rather than its replacement. The first pillar, 'AI Accounts for All', aims to prevent the digital divide by providing free access to advanced, licensed AI tools for all students.

¹⁴ The countries were selected based on their evaluation within the European Commission's 'State of the Digital Decade 2025' report. Retrieved 19.2.2026. from <https://digital-strategy.ec.europa.eu/en/library/state-digital-decade-2025-report>

¹⁵ DIGIVISIO. Retrieved 19.2.2026. from <https://digivisio2030.fi/en/basic-information-on-the-digivisio-2030-programme/>

¹⁶ VILLE. Retrieved 21.2.2026. from <https://en.learninganalytics.fi/ville>

As of September 2025, approximately 20,000 access accounts were provided for students and about 3,000 for teachers. The second pillar, mass education of teaching staff, focuses not only on technical use but on the pedagogical grounding of these tools—specifically, how to use AI for personalized learning and reducing administrative burdens. Training has commenced for 3,000 teachers, with a target of 5,000 by spring 2027.¹⁷ The development of 'tutor' AI tools and AI literacy represents the final pillar. Instead of standard models like ChatGPT that provide immediate solutions, the Estonian system encourages the development of scaffolded AI. This means the AI tool is programmed not to answer a student's query directly, but to respond with a follow-up question or a hint that guides the student. This approach seeks to prevent the automation of basic skills (memorization and mere listing) and encourages higher-order thinking skills, such as critical thinking and analysis (Lepik-Verliin, Hint, Leijen, 2025). In any discussion on AI integration, it is necessary to address its ethical dimensions. The AI Leap program is aligned with the EU AI Act and implements strict data protection protocols, preventing the use of student data for training commercial models without explicit consent. Unlike free versions of AI tools that use user inputs to train future models, the Estonian system utilizes institutional API licenses,¹⁸ meaning data entered by students and teachers remains within a 'closed loop.' Any work utilizing AI must include an 'AI Disclosure Statement', in which the student precisely specifies the phase (research, proofreading, structuring) in which the technology was used. Concealing the use of AI is treated as a serious breach of the Code of Ethics (Lepik-Verliin, Hint, Leijen, *op. cit.*). Furthermore, human-in-the-loop supervision is required, preventing algorithms from making autonomous decisions about students, especially in assessment procedures. Digital linguistic sovereignty is also developing. Estonia is developing its own Large Language Models (LLMs), such as GPT-4, Claude, and Gemini. These models are fine-tuned on Estonian language texts to understand their unique grammatical, morphological, and cultural characteristics. Standard global models are primarily trained in English. They often fail in complex Estonian morphology or incorporate American cultural values (Barbu, Muru, Malva, 2025, p. 135). Local models, such as those developed by the University of Tartu, ensure that AI operates within the Estonian context. Pilot activities began in September 2025, so further work is expected to increase transparency in AI use and ensure ethical standards.

4. ADVANCING DIGITAL MATURITY IN CROATIAN HIGHER EDUCATION: KEY RECOMMENDATIONS

Based on the analysis of the digital transformation of higher education systems in Croatia, Finland, and Estonia, it is possible to formulate key recommendations for improving the Croatian academic context by applying evidence-based models and best practices. A priority step involves the adoption of strategic documents by universities, and subsequently by their constituent units, dedicated exclusively to digital transformation. This would overcome the current practice of fragmented integration of these goals into general development strategies and policies that diversely regulate specific areas of scientific, teaching, and professional work. Such an approach ensures coherence with the national Digital Croatia Strategy 2032 and enables precise resource planning for infrastructure modernization and the development of digital competencies for both academic and non-academic staff. Significant potential for enhancing the instructional process lies in the implementation of Data-Driven Pedagogy, which relies on the systematic analysis of students' digital footprints within learning management systems.

¹⁷ Euridyce. *Estonia: AI Leap Initiative to Enhance Learning and Teaching*. Retrieved 21.2.2026. from <https://euridyce.eacea.ec.europa.eu/news/estonia-ai-leap-initiative-enhance-learning-and-teaching>

¹⁸ TI-Hüpe. Retrieved 21.2.2026. from <https://tihupe.ee/en/>

This proactive model enables real-time personalized learning and the development of platforms with immediate feedback loops, thereby fostering self-regulated learning, students' metacognitive reflection on their own progress, and responsibility for achieving learning outcomes. Additionally, it is necessary to provide financial and administrative incentives for the development and accreditation of new online and HyFlex programs to offer students more flexible study options, given that the current share of such programs in the total number of accredited study programs stands at a mere 1.1%.

In the sphere of integrating AI into higher education, the initial phase should focus on the development—and the long-term implementation—of models similar to the Estonian AI Leap program. Emphasis should be placed on developing comprehensive AI literacy and ensuring institutional access to licensed tools to neutralize the socio-economically driven digital divide. In doing so, it is crucial to develop specific cognitive supports (scaffolded AI) that guide student learning through follow-up questions rather than providing automated solutions, thus encouraging the essential development of higher-order cognitive skills. Furthermore, systematic efforts toward ensuring digital linguistic sovereignty through the development of large language models tailored to the specificities of the Croatian language should be considered a long-term strategic goal of the national government. Finally, the urgent establishment of ethical and legal frameworks aligned with EU strategic documents on AI is essential. These frameworks should precisely regulate data protection, ensure transparency through mandatory AI disclosure statements, and guarantee constant human-in-the-loop supervision in assessment processes, for instance, through the establishment of ethical committees for the oversight of algorithmic grading.

5. CONCLUSION

Higher education stands at a pivotal crossroads. Emerging technologies, evolving expectations, and market pressures are necessitating that institutions redefine their pedagogical delivery models and the articulation of their value propositions. In this regard, digital transformation transcends the mere adoption of digital tools; it represents a human-centric trajectory that redesigns educational frameworks into innovation-driven learning systems. Concurrently, the integration of nascent technologies—such as artificial intelligence, augmented reality, and virtual reality—offers significant potential for personalization, adaptive feedback, and immersive learning experiences. Within this paradigm, educators are shifting from the dissemination of knowledge toward interactive, student-centered learning (Bojadziewska Danevska, 2025, p. 213). The digital transformation of the Croatian higher education sector has commenced, though it remains in its nascent and fragmented stages. While the digitalization of university administrative systems and the introduction of foundational digital teaching methods began over a decade ago, it was the COVID-19 pandemic that catalyzed the implementation of digital assessment methodologies. Regarding digital infrastructure, current investments remain in the preliminary phase, primarily focused on ensuring high-speed connectivity, cybersecurity, the establishment of data centers, and the technical equipping of facilities for hybrid instruction. A significant systemic deficiency is evidenced by the exceptionally low number of accredited online study programs, totaling only 20. It is hypothesized that this figure will increase following the implementation of more advanced digital infrastructure, alongside the expected integration of additional contemporary e-learning tools, particularly those modeled after the Finnish and Estonian higher education systems. Furthermore, the segments of digital transformation that have been implemented are not adequately supported by the strategic documents of most Croatian universities.

Beyond the lack of digital transformation strategies, there is a notable absence of regulation regarding the use of AI tools in scientific and pedagogical processes—both at the national level and within most universities—an issue that warrants immediate attention given the advanced developmental stage of generative AI. Although polytechnics and individual faculties were not encompassed by this phase of the research, a review of official university websites identified isolated cases of faculties that have adopted digital transformation and cybersecurity strategies. Consequently, to gain a more comprehensive insight, a quantitative study on the digital maturity of Croatian higher education is planned, which will extend to include both public and private polytechnics and faculties. In conclusion, the successful digital transformation of Croatian higher education necessitates a transition from primarily infrastructural provisioning and foundational e-learning tools toward more complex pedagogical innovations and practices, enhanced interoperability of scientific databases, and robust ethical regulation.

ACKNOWLEDGEMENT: *This paper has been written and presented within the scope of the project „EduLex: Enhancing the Quality of the Legal Framework in Higher Education in the Republic of Croatia” (uniri-mzi-25-36), funded by European Union – NextGenerationEU via the Croatian National Recovery and Resilience Plan 2021-2026, in conjunction with the University of Rijeka, Faculty of Law Programme Financing. The views and opinions expressed are solely those of the authors and do not necessarily reflect the official position of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.*

LITERATURE:

1. Act on Higher Education and Scientific Activity, Official Gazette no. 119/22
2. Aru-Chabilan, H. (2020) Tiger Leap for digital turn in the Estonian education. Educational Media International, Volume 57, Issue 1, pp. 61-72
3. Barbu, E., Muru, M., Malva, S.M. (2025). *Improving Estonian Text Simplification through Pretrained Language Models and Custom Datasets*, p. 135. Retrieved 21.2.2026. from <https://aclanthology.org/2025.ranlp-1.16.pdf>
4. Bedeković, M., Grubišić, K. (2024). Digitalizacija javne uprave i njezina primjena u odabranim područjima. Zagrebačka pravna revija, Volume 13, Issue 1 (2024), pp. 98-127
5. Bojadziewska Danevska, A. (2025). *Integrating Technology and Growth Mindset Principles into Innovative Teaching Strategies*. Retrieved 21.2.2026. from <https://www.jstor.org/stable/jj.37105659.17>
6. CARNET, Retrieved 15.2.2026. from <https://www.carnet.hr/>
7. Casillas Alvarado, M., Ramirez Martinell, A., Rozenbraver Lopez, O. (2024). Periods of Technological Change in Higher Education. *Journal of Comparative & International Higher Education*, Volume 16, Issue 2 (2024), pp. 136-151
8. Croatian Qualifications Framework Act, Official Gazette no. 22/13, 41/16, 64/18, 47/20, 20/21
9. Digital Croatia Strategy until 2032, Official Gazette no. 2/2023
10. Dixon, N., Howe, R., Richter, U.M. (2025). Exploring learning analytics practices and their benefits through the lens of three case studies in UK higher education. *Research in Learning Technology*, 33. Retrieved 21.2.2026. from <https://doi.org/10.25304/rlt.v33.3127>
11. e-Sveučilišta. Retrieved 18.2.2026. from <https://www.carnet.hr/projekt/e-sveucilista/>
12. European Commission. (2020). Digital Education Action Plan (2021-2027)
13. European Commission. COM(2021) 118 final, 9.3.2021

14. European Commission. (2025). State of the Digital Decade 2025 report. Retrieved 19.2.2026. from <https://digital-strategy.ec.europa.eu/en/library/state-digital-decade-2025-report>
15. Euridyce. Estonia: AI Leap Initiative to Enhance Learning and Teaching. Retrieved 21.2.2026. from <https://eurydice.eacea.ec.europa.eu/news/estonia-ai-leap-initiative-enhance-learning-and-teaching>
16. Government of the Republic of Croatia. (2021). National Recovery and Resilience Plan 2021-2026
17. Kučina Softić, S., Odak, M., Lasić Lazić, J. (2021). *Digitalna transformacija. Novi pristupi i izazovi u obrazovanju*. Sveučilište Sjever, Koprivnica
18. Lepik-Verliin, K., Hint, H., Leijen, D.A.J. (2025). AI Competence Frameworks and Policies in Higher Education: Analysis and Recommendations. National Report by University of Tartu. Retrieved 21.2.2026. from https://www.wu.ac.at/fileadmin/wu/o/wu4juniors/LLE/FLAIR/National_Report_Estonia.pdf
19. Levin, R.C. (2024). Online Learning & the Transformation of Global Higher Education. *Journal of the American Academy of Arts and Sciences*, Volume 153, Issue 2 (2024), p. 262-274
20. Liu, Y. (2025). Challenges and Strategies for the Advancement of Legal Governance in Universities in the Era of Digital Intelligence. *Beijing Law Review*, Volume 16, Issue 1 (2025), pp. 387-397
21. National Development Strategy of the Republic of Croatia until 2030, Official Gazette no. 13/2021
22. OECD. (2021). *The State of Higher Education. One Year into the COVID-19 pandemic*. OECD
23. Ordinance on Student Document, Official Gazette no. 101/23
24. Ordinance on the Conditions and Manner of Exercising the Right to Coverage of Student Meal Costs, Official Gazette no. 120/13
25. Ordinance on the Content and Use of Information Systems in Higher Education, Official Gazette no. 36/23
26. Ordinance on the Structure of the Authentication and Authorisation Infrastructure of Science and Higher Education in the Republic of Croatia – AAI@EduHr, retrieved 17 February 2026
from <https://wiki.srce.hr/spaces/AAIUPUTE/pages/65405172/Dokumenti?preview=/65405172/65405186/AAI%40EduHr-pravilnik-ver1.3.1.pdf>
27. Ouatik, F. et al. (2022). Predicting Student Success Using Big Data and Machine Learning Algorithms. *International Journal of Emerging Technologies in Learning*, Volume 17, Issue 12, pp. 236–251.
28. Scarito, A. (2026). Estonia and AI Leap 2025. Retrieved 21.2.2026. from DOI:10.13140/RG.2.2.10321.80489
29. Shuetze, H.G., de Vries, W., Mendiola, G.A. (2024). Digitalization of Higher Education: An Introduction. *Journal of Comparative & International Higher Education*, Volume 16, Issue 2 (2024), pp. 13-24
30. SRCE. Retrieved 15.2.2026. from <https://www.srce.unizg.hr/>
31. Teräs, M. et al. (2020). Learning analytics for students: synthesis of two user needs studies in Finnish higher education. In *Proceedings of EdMedia + Innovate Learning*, pp. 455-463. Online, The Netherlands: Association for the Advancement of Computing in Education.

32. TI-Hüpe. Retrieved 21.2.2026. from <https://tihupe.ee/en/>
33. University North. (2025). Smjernice za odgovorno korištenje alata AI. Retrieved 19.2.2026. from https://www.unin.hr/wp-content/uploads/Uz-Pravilnik-o-zavr%C5%A1nim-radovima_Smjernice-za-odgovorno-kori%C5%A1tenje-AI-alata_SS.pdf
34. University of Rijeka. (2024). Politika korištenja alata AI na Sveučilištu u Rijeci. Retrieved 19.2.2026. from https://uniri.hr/wp-content/uploads/2025/12/2024_01_23_Politika_koristenja_alata_UI-a-1.pdf
35. University of Rijeka. (2025), Smjernice za odgovorno korištenje alata umjetne inteligencije na Sveučilištu u Rijeci. Retrieved 19.2.2026. from file:///D:/Users/Korisnik/Downloads/2025_12_16_Smjernice_za_odgovorno_koristenje_alata_UI-a-1.pdf
36. University of Zagreb. (2024). Strateške smjernice digitalne transformacije Sveučilišta u Zagrebu do 2032. godine. Retrieved 18.2.2026. from https://www.unizg.hr/fileadmin/rektorat/O_Sveucilistu/Dokumenti_javnost/Dokumenti/Strateski_dokumenti/Strateske_smjernice_digitalne_transformacije_UniZG_210x280_mm_11_10_24.pdf
37. VILLE. Retrieved 21.2.2026. from <https://en.learninganalytics.fi/ville>

DIGITAL SCARCITY APPEALS IN TOURISM PLATFORMS: A DOUBLE-EDGED SWORD FOR CIRCULAR TOURISM CONSUMPTION

Erisa Mancellari

*Faculty of Economics, University of Tirana
Tirana, Albania
erisa.mancellari@unitir.edu.al*

Gentjan Cera

*Faculty of Economics and Agribusiness, Agricultural University of Tirana
Tirana, Albania
gcera@ubt.edu.al*

Shpresim Domi

*Faculty of Economics and Agribusiness, Agricultural University of Tirana
Tirana, Albania
shdomi@ubt.edu.al*

ABSTRACT

Tourism platforms increasingly employ technology-mediated scarcity messages to accelerate booking decisions, yet their implications for the transition toward a circular economy remain largely unexplored. This conceptual paper draws on Dual-Process Theory to examine how digital scarcity appeals shape tourists' decision-making in a circular consumption context. We propose a conceptual framework suggesting that while circular tourism requires deliberate, reflective evaluation associated with System 2, scarcity cues often activate faster System 1 heuristics that alter how travelers evaluate tourism options. The framework identifies two contrasting psychological pathways. First, demand-based scarcity cues (e.g., "Only 1 room left") trigger fear of missing out (FOMO) and competitive arousal, encouraging rapid, linear booking decisions that hinder circular tourism. Second, re supply-based scarcity cues emphasizing exclusivity may activate a uniqueness heuristic, enhancing the perceived prestige and desirability of resource-efficient tourism experiences. Additionally, time-based scarcity cues may support circularity when used to match demand with otherwise unused capacity. By integrating insights from scarcity marketing and circular economy research, this paper contributes a novel perspective on how digital choice architectures in tourism platforms can either undermine or facilitate circular consumption. The study suggests that shifting from high-arousal urgency tactics toward exclusivity-framed nudges may help align instinctive consumer behavior with sustainability goals in tourism.

Keywords: *Circular Economy, Tourism, Scarcity appeals, Circular tourist, Digital scarcity, Booking platforms, Dual-Process Theory*

1. INTRODUCTION

Tourism represents one of the most significant global industries, contributing substantially to economic growth, employment, and wealth creation worldwide, accounting for approximately 10% of global GDP and supporting more than 350 million jobs (World Bank, 2024). Despite these benefits, tourism activities generate considerable environmental pressures through intensive resource consumption, waste generation, and biodiversity loss, highlighting the need for more sustainable models of tourism development (Florido et al., 2019; Manniche et al., 2021; Rodríguez et al., 2020).

The circular economy has increasingly been proposed as a promising framework to address these sustainability challenges by promoting resource efficiency, waste reduction, and a regenerative system of production and consumption (Geissdoerfer et al., 2017; Kirchherr et al., 2023). However, although circular economy principles emphasize reducing, reusing, and recycling resources, existing research in tourism has largely focused on organizational practices and government mechanisms, while paying limited attention to the psychological and contextual factors shaping tourists' decision-making (Julião et al., 2019; Manniche et al., 2021; Sørensen & Bærenholdt, 2020). To address this limitation, this study examines the role of scarcity appeals in shaping tourism consumption within the context of the circular economy. Drawing on insights from circular economy research and the psychology of scarcity, the paper develops a conceptual framework explaining how scarcity cues, commonly used in tourism marketing and digital platforms, may influence the adoption of circular tourism choices. Scarcity refers to messages communicating the potential unavailability of a product or service in the future, while it remains available in the present, thereby increasing its perceived value and desirability (Cialdini, 1993; Lynn, 1991). Prior research shows that scarcity cues such as limited quantity or time-restricted offers, can significantly increase purchase intention and perceived value through mechanisms such as fear of missing out (FOMO), social comparison, and the desire for uniqueness (Aggarwal et al., 2011; Gierl et al., 2008; Hodgkinson, 2019; Lynn, 1991; Roy & Sharma, 2015). By integrating these insights with Circular economy principles, this study contributes to the literature by identifying how scarcity-based communications may either undermine circular tourism by encouraging rapid consumption or be leveraged to promote more mindful and resource-conscious travel choices. The remainder of the paper reviews the literature on circular economy in tourism and scarcity appeals in consumer behavior, followed by the development of a conceptual framework explaining the dual role of scarcity appeals in shaping circular tourism consumption.

2. LITERATURE REVIEW

2.1. Circular Economy in Tourism: Principles and Human Factors

The circular economy (CE) is broadly defined as a regenerative production-consumption system that seeks to decouple economic growth from resource depletion by replacing the linear take-make-dispose model with closed-loop processes (Geissdoerfer et al., 2017; Kirchherr et al., 2023; Suárez-Eiroa et al., 2019). Although academic definitions vary in scope, they consistently emphasize a system in which resource input, waste generation, and energy leakage are minimized through the strategic slowing, closing, and narrowing of material loops (Geissdoerfer et al., 2017). This transition requires maintaining the value of resources for as long as possible within planetary boundaries, relying heavily on design innovation and consumer education while replacing the traditional “end-of-life” concept with practices such as reducing, reusing, recycling, and recovering materials (Ellen MacArthur Foundation, 2023; Kirchherr et al., 2023; Suárez-Eiroa et al., 2019). Importantly, this model operates across micro (consumer-company), meso (eco-industrial parks), and macro (national) levels to support sustainable development that balances environmental quality with economic prosperity (Kirchherr et al., 2023).

Within the tourism industry, the application of circular principles is particularly important because the sector largely operates according to a linear model that relies on substantial amounts of non-renewable resources and generates significant environmental impacts (Florido et al., 2019; Rodríguez et al., 2020). Studies show that the circular economy is regarded as a key approach for advancing sustainability in the tourism sector while simultaneously creating value (Axhami et al., 2023; Manniche et al., 2021; Rosato et al., 2021).

Despite its growing relevance, the implementation of circular practices in tourism remains at an early stage, and it's often limited to organizational cost-savings initiatives, rather than a comprehensive systemic transition (Manniche et al., 2021; Rodríguez-Antón & Alonso-Almeida, 2019). Achieving meaningful circularity, therefore, requires the active engagement of multiple stakeholders, particularly the “circular tourist”, who must make intentional and resource-efficient consumption decisions (Cornejo Ortega & Malcolm, 2020; Florido et al., 2019; Sørensen & Bærenholdt, 2020). However, prior research highlights a persistent value-action gap (Julião et al., 2019), whereby even environmentally conscious travelers struggle to translate sustainability attitudes into actual booking behaviors. This discrepancy suggests that the transition toward circular tourism may be strongly influenced by the psychological context in which travel decisions are made, particularly within digital booking environments.

2.2 Digital Scarcity Appeals in Tourism Context

Scarcity appeals are among the most widely employed marketing strategies and have long been recognized for their influence on consumer choice (Cialdini, 1993; Lynn, 1991; Shi et al., 2020). Extensive research identifies scarcity as a powerful driver of consumer responses, demonstrating that scarcity cues increase purchase intention and willingness to pay by enhancing perceived value, desirability, and urgency (Aggarwal et al., 2011; Gupta & Gentry, 2019; Roy & Sharma, 2015; Teubner & Graul, 2020). In digital environments, scarcity appeals often take the form of technology-mediated messages that signal the potential future unavailability of a product or service, thereby increasing its perceived value and desirability in the present (Banerjee et al., 2025; Lynn, 1991). Within the highly competitive electronic marketplace of tourism platforms, such cues operate alongside other informational signals, including consumer ratings and popularity indicators, which collectively function as digital nudges that accelerate consumer-decision making and, if managed carefully, maximize customers' booking intention (Park et al., 2017). Given this background, online booking platforms frequently employ multiple forms of scarcity appeals designed to increase perceived demand, exclusivity, or urgency. In the tourism industry, scarcity appeals have become a widely used marketing tactic to increase conversion rates on both traditional hotel booking platforms and peer-to-peer accommodation marketplaces (Teubner & Graul, 2020). These technology-mediated scarcity appeals signal that a travel service may become unavailable due to either high demand or limited supply (Huang et al., 2020). Within online booking environments, such appeals can be categorized according to their framing and the psychological responses they trigger in travelers. Quantity scarcity messages, such as “Only 1 room left”, indicate a limited number of available units and are particularly effective in hospitality settings because they increase the perceived risk of selling out (Song et al., 2019). These cues are applied differently across platforms: hotel booking sites often use them to communicate inventory limitations, whereas peer-to-peer platforms like Airbnb emphasize the unique and one-of-a-kind nature of a listing, enhancing perceived exclusivity and value (Teubner & Graul, 2020). Tourism marketers also frame scarcity in terms of demand or supply, highlighting that accommodations are limited either because many consumers are booking them (demand framing) or because only a small number of units are available (supply framing). Research shows that demand-framed scarcity appeals are especially persuasive for consumers with a high sense of power, who view popularity as a signal of quality, while supply-framed scarcity activates consumers' need for uniqueness, making destinations appear more exclusive and prestigious (Huang et al., 2020; Kim et al., 2020). Time-limited offers such as “Deal expires in 12 hours” create immediate decision pressure, but their effectiveness is moderated by booking lead time, which refers to the interval between reservation and the stay. When lead time is long, unit scarcity is perceived as more credible and influential, whereas for last-minute bookings, temporal scarcity heightens urgency and can trigger “purchase fever” (Song et al., 2019).

However, such pressure may also increase the likelihood of post-purchase cognitive-dissonance if travelers later feel that their decision was rushed (Kim et al., 2020). Despite extensive research on scarcity appeals in marketing and the growing interest in circular tourism, little attention has been paid to how digital scarcity cues influence tourists' cognitive processing when evaluating circular tourism options.

3. CONCEPTUAL FRAMEWORK: THE DUAL ROLE OF SCARCITY

The theoretical tension between digital scarcity and circular tourism can be understood through the lens of Dual-Process Theory (Evans, 2008; Kahneman, 2011). Dual-Process Theory proposes that human decision-making operates through two distinct cognitive systems: System 1, which is fast, automatic, and heuristic-driven, and System 2, which is slower, deliberative, and analytical (Evans, 2008). While transitioning to a circular economy requires the deliberate, effortful evaluation of System 2, digital scarcity cues often can “hijack” this process, forcing consumers into System 1 heuristic processing. While scarcity literature suggests these responses are fast and instinctive, they trigger different psychological motivations, depending on the cue framing (Aggarwal et al., 2011; Lynn, 1991; Shi et al., 2020).

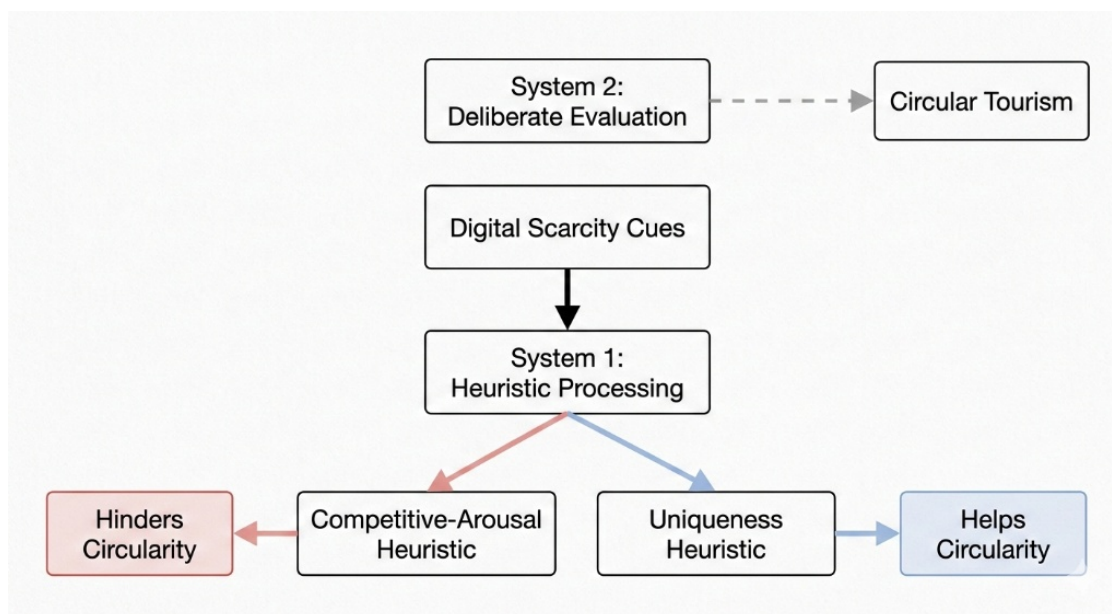


Figure 1: Conceptual Framework of the dual pathways of scarcity in circular tourism (Source: Developed by the authors)

3.1. The “Hinder” Pathway: Competitive arousal and FOMO

Circular tourism requires “slow” System 2 thinking to evaluate long-term sustainability. However, high-arousal scarcity cues (e.g., “Only 1 room left!”), trigger a low-elaboration heuristic rooted in herding effects, competitive-arousal, and FOMO (Coker, 2020; Hodkinson, 2019; Teubner and Graul, 2020). As highlighted by Song et al. (2019), quantity-based scarcity increases the perceived risk of unavailability, including “purchase fever”. In this state, the tourist’s primary cognitive goal shifts from evaluating circular attributes such as resource efficiency or waste management to the immediate goal of securing the service. This competitive arousal (Teubner and Graul, 2020) bypasses deliberate reflection in favor of rapid, linear consumption. The FOMO heuristic effectively blinds the consumer to circular performance, prioritizing the avoidance of regret over responsible decision-making.

Proposition 1: High-arousal demand-based scarcity cues (e.g., unit scarcity) hinder circular tourism by triggering a FOMO-driven competitive-arousal that prioritizes immediate acquisition over deliberate sustainability evaluation.

3.2. The “Help” Pathway: The Uniqueness Heuristic and Resource Value

While still operating as a System 1 heuristic, supply-framed scarcity (e.g., “Limited edition stay, or Limited edition experience”) triggers the “scarcity-as-exclusivity shortcut.” (Jang et al., 2015; Wu and Lee, 2016). Rather than inducing panic, these cues activate the Consumer’s Need for Uniqueness (Roy and Sharma, 2015; Wang et al., 2022) and may help promote more sustainable options and manage resources efficiently. This heuristic can be further leveraged to increase the perceived value and prestige of “slow” tourism products and services. If a circular tourism experience is framed as an exclusive “trophy of achievement”, the uniqueness heuristic drives travelers toward high-value, resource-efficient options. This aligns with the circular economy goal of maintaining resource value (Kirchherr et al., 2023; Suárez-Eiroa et al., 2019) by shifting the focus from quantity to exclusivity.

Proposition 2: Supply-frame scarcity cues help circular tourism by triggering a uniqueness heuristic that enhances the perceived prestige of circular tourism products or services, appealing to the desire for exclusivity.

Proposition 3: Time-based scarcity cues can support circularity by facilitating resource efficiency, filling otherwise unused capacity (perishable inventory), provided they are framed to encourage value-matching rather than high arousal FOMO.

A critical factor in the success of the circular transition is long-term tourist behavior. Kim et al. (2020) found that high-pressure scarcity tactics, particularly those leveraging FOMO, can lead to post-purchase cognitive dissonance. If a traveler feels manipulated into a rushed decision, they may experience regret, which is detrimental to the “repeat” and “responsible” behaviors necessary for a regenerative tourism system. For a circular economy to thrive tourist must feel empowered by their choices, not coerced by urgent digital nudges.

4. DISCUSSION AND CONCLUSION

4.1 Theoretical Contributions

This paper contributes to the literature by integrating research on digital scarcity marketing with circular economy consumption through the lens of Dual-Process Theory. Prior studies have highlighted the persistent “value-action” gap in sustainable tourism, whereas travelers express pro-environmental intentions but often make less sustainable choices in practice (Julião et al., 2019). Our framework suggests that this gap may partly result from the dominance of heuristic processing in digital booking environments. Specifically, we propose that the framing of scarcity cues determines which heuristic pathway is activated during decision-making. Conventional scarcity messages on tourism platforms, especially those based on limited quantity due to high demand, tend to trigger fear of missing out (FOMO), encouraging rapid consumption decisions that prioritize immediate booking. In contrast, supply-framed scarcity may activate a uniqueness heuristic, increasing the perceived desirability of distinctive or limited tourism offerings, including circular or eco-certified accommodations. This perspective moves beyond the binary view of scarcity as inherently manipulative. Instead, it highlights that scarcity cues can influence consumer behavior through different heuristic mechanisms depending on how they are framed.

In this way, the framework suggests that intuitive decision processes do not necessarily conflict with circular consumption; under certain conditions, heuristic processing may also support sustainable choices. More broadly, the conceptual framework identifies two competing heuristic pathways in digital tourism environments: a FOMO-driven pathway, which may accelerate linear consumption, and a uniqueness-driven pathway, which may enhance the attractiveness of circular tourism options.

4.2 Managerial and Policy Implications

The findings offer several implications for tourism platforms such as Booking.com and Airbnb. In particular, platform designers can apply principles of ethical choice architecture to better align booking environments with circular economy goals. First, platforms may consider moderating high-urgency scarcity cues for standard accommodations. Messages emphasizing extreme quantity scarcity (e.g., “Only 1 room left!”) can trigger FOMO responses and encourage rapid decisions, potentially reducing the attention of travelers to circular attributes such as eco-certifications or sustainability practices. Second, platforms should leverage exclusivity framing for circular tourism products. Highlighting the limited availability of regenerative, locally integrated, or eco-friendly accommodations may activate the uniqueness heuristic, allowing sustainable options to be perceived as distinctive and desirable rather than as compromises. Finally, transparency in scarcity messages is important. Clearly communicating the basis of scarcity claims can reduce the risk of post-purchase dissonance and maintain customer trust, which is essential for fostering long-term responsible consumption behavior.

4.3 Limitations and Future Research

As a conceptual study, the proposed framework requires empirical validation. Future research could employ experimental designs to test whether supply-framed scarcity cues increase consumer engagement with circular tourism options compared with traditional urgency-based scarcity messages. Additionally, future studies could explore potential moderating variables, such as digital literacy or environmental involvement, which may influence how travelers interpret and respond to scarcity cues in online environments. Another limitation concerns context. The present framework focuses primarily on digital tourism platforms, where algorithmically generated scarcity messages are common. Further research could examine whether similar psychological mechanisms operate in offline tourism decision contexts, such as travel agencies or non-site booking environments.

ACKNOWLEDGEMENT: *This research is supported by a READ (Research Expertise from the Academic Diaspora) and AKKSHI (National Agency for Scientific Research and Innovation, Albania) project titled "The psychological impact of scarcity appeals on consumer behavior. A comparative study between Balkan and Western European markets."*

LITERATURE:

1. Aggarwal, P., Jun, S. Y., & Huh, J. H. (2011). Scarcity Messages. *Journal of Advertising*, 40(3), 19–30. <https://doi.org/10.2753/JOA0091-3367400302>
2. Axhami, M., Ndou, V., Milo, V., & Scorrano, P. (2023). Creating value via the circular economy: Practices in the tourism sector. *Administrative Sciences*, 13(7), 166.
3. Banerjee, S., Pal, A., Kapetanaki, A. B., & Liyanage, C. (2025). Technology-mediated scarcity messages: A systematic literature review. *Internet Research*, 1–45. <https://doi.org/10.1108/INTR-11-2023-1084>
4. Cialdini, R. B. (1993). *Influence: The psychology of persuasion*. Harper Business.

5. Coker, B., 2020. Arousal enhances herding tendencies when decision-making. *J of Consumer Behaviour* 19, 229–239. <https://doi.org/10.1002/cb.1811>
6. Cornejo Ortega, J. L., & Malcolm, C. D. (2020). Touristic stakeholders' perceptions about the smart tourism destination concept in Puerto Vallarta, Jalisco, Mexico. *Sustainability*, 12(5), 1741.
7. Ellen MacArthur Foundation. (2023). Circular economy introduction. <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>
8. Evans, J.St.B.T., 2008. Dual-Processing Accounts of Reasoning, Judgment, and Social Cognition. *Annu. Rev. Psychol.* 59, 255–278. <https://doi.org/10.1146/annurev.psych.59.103006.093629>
9. Florido, C., Jacob, M., & Payeras, M. (2019). How to carry out the transition towards a more circular tourist activity in the hotel sector. The role of innovation. *Administrative Sciences*, 9(2), 47.
10. Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy—A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768.
11. Gierl, H., Plantsch, M., & Schweidler, J. (2008). Scarcity effects on sales volume in retail. *The International Review of Retail, Distribution and Consumer Research*, 18(1), 45–61. <https://doi.org/10.1080/09593960701778077>
12. Gupta, S., & Gentry, J. W. (2019). 'Should I Buy, Hoard, or Hide?'- Consumers' responses to perceived scarcity. *The International Review of Retail, Distribution and Consumer Research*, 29(2), 178–197. <https://doi.org/10.1080/09593969.2018.1562955>
13. Hodgkinson, C. (2019). 'Fear of Missing Out' (FOMO) marketing appeals: A conceptual model. *Journal of Marketing Communications*, 25(1), 65–88. <https://doi.org/10.1080/13527266.2016.1234504>
14. Huang, H., Liu, S. Q., Kandampully, J., & Bujisic, M. (2020). Consumer responses to scarcity appeals in online booking. *Annals of Tourism Research*, 80, 102800.
15. Jang, W.E., Ko, Y.J., Morris, J.D., Chang, Y., 2015. Scarcity Message Effects on Consumption Behavior: Limited Edition Product Considerations. *Psychology and Marketing* 32, 989–1001. <https://doi.org/10.1002/mar.20836>
16. Julião, J., Gaspar, M., Tjahjono, B., & Rocha, S. (2019). Exploring Circular Economy in the Hospitality Industry. In J. Machado, F. Soares, & G. Veiga (Eds.), *Innovation, Engineering and Entrepreneurship* (Vol. 505, pp. 953–960). Springer International Publishing. https://doi.org/10.1007/978-3-319-91334-6_131
17. Kahneman, D., 2011. *Thinking, fast and slow*. macmillan.
18. Kim, E.J., Choi, C., Tanford, S., 2020. Influence of scarcity on travel decisions and cognitive dissonance. *Asia Pacific Journal of Tourism Research* 25, 721–735. <https://doi.org/10.1080/10941665.2020.1720258>
19. Kirchherr, J., Yang, N.-H.N., Schulze-Spüntrup, F., Heerink, M.J., Hartley, K., 2023. Conceptualizing the circular economy (revisited): an analysis of 221 definitions. *Resources, conservation and recycling* 194, 107001.
20. Lynn, M. (1991). Scarcity effects on value: A quantitative review of the commodity theory literature. *Psychology & Marketing*, 8(1), 43–57. <https://doi.org/10.1002/mar.4220080105>
21. Manniche, J., Larsen, K. T., & Broegaard, R. B. (2021). The circular economy in tourism: Transition perspectives for business and research. *Scandinavian Journal of Hospitality and Tourism*, 21(3), 247–264. <https://doi.org/10.1080/15022250.2021.1921020>
22. Park, K., Ha, J., & Park, J.-Y. (2017). An Experimental Investigation on the Determinants of Online Hotel Booking Intention. *Journal of Hospitality Marketing & Management*, 26(6), 627–643. <https://doi.org/10.1080/19368623.2017.1284631>

23. Rodríguez, C., Florido, C., & Jacob, M. (2020). Circular economy contributions to the tourism sector: A critical literature review. *Sustainability*, 12(11), 4338.
24. Rodríguez-Antón, J. M., & Alonso-Almeida, M. del M. (2019). The circular economy strategy in hospitality: A multicase approach. *Sustainability*, 11(20), 5665.
25. Rosato, P. F., Caputo, A., Valente, D., & Pizzi, S. (2021). 2030 Agenda and sustainable business models in tourism: A bibliometric analysis. *Ecological Indicators*, 121, 106978.
26. Roy, R., & Sharma, P. (2015). Scarcity Appeal in Advertising: Exploring the Moderating Roles of Need for Uniqueness and Message Framing. *Journal of Advertising*, 44(4), 349–359. <https://doi.org/10.1080/00913367.2015.1018459>
27. Shi, X., Li, F., & Chumnumpan, P. (2020). The use of product scarcity in marketing. *European Journal of Marketing*, 54(2), 380–418. (world). <https://doi.org/10.1108/EJM-04-2018-0285>
28. Song, M., Noone, B.M., Han, R.J., 2019. An examination of the role of booking lead time in consumers' reactions to online scarcity messages. *International Journal of Hospitality Management* 77, 483–491.
29. Sørensen, F., & Bærenholdt, J. O. (2020). Tourist practices in the circular economy. *Annals of Tourism Research*, 85, 103027.
30. Suárez-Eiroa, B., Fernández, E., Méndez-Martínez, G., & Soto-Oñate, D. (2019). Operational principles of circular economy for sustainable development: Linking theory and practice. *Journal of Cleaner Production*, 214, 952–961.
31. Teubner, T., & Graul, A. (2020). Only one room left! How scarcity cues affect booking intentions on hospitality platforms. *Electronic Commerce Research and Applications*, 39, 100910. <https://doi.org/10.1016/j.elerap.2019.100910>
32. Wang, Y., Kong, S., Li, M., Liu, L., 2022. Need for uniqueness moderates the effectiveness of different types of scarcity appeals. *Frontiers in Psychology* 13, 890350.
33. Wu, L., Lee, C., 2016. Limited edition for me and best seller for you: The impact of scarcity versus popularity cues on self versus other-purchase behavior. *Journal of Retailing* 92, 486–499.
34. World Bank. (2024). Tourism and Competitiveness. World Bank. <https://www.worldbank.org/en/topic/competitiveness/brief/tourism-and-competitiveness>

AI AND COMMUNICATION LITERACY IN JOURNALISM AND PUBLIC RELATIONS

Zlatko Vidackovic

Croatian National Theatre, Zagreb

zlatko.vidackovic@gmail.com

ABSTRACT

The rapid integration of artificial intelligence into media production, information management, and public communication has profoundly reshaped professional practices in journalism and public relations. AI-driven tools are increasingly used for content generation, audience targeting, data analysis, and strategic messaging, promising greater efficiency, personalization, and scalability. At the same time, these technologies introduce significant challenges related to credibility, transparency, accountability, ethical responsibility, and the long-term sustainability of public trust in digital communication environments. This paper approaches artificial intelligence not primarily as a technological or economic innovation, but as a communication literacy challenge with direct implications for inclusive social development and sustainable digital societies. Drawing on communication and media studies, the paper conceptualizes AI literacy as an expanded form of communication literacy, encompassing a critical understanding of algorithmic mediation, automated content production, data-driven narratives, and evolving forms of human-machine collaboration in the public sphere. Particular attention is given to how journalists and public relations practitioners operate within AI-driven communication environments and to the institutional responsibilities that arise from these practices, as their roles increasingly involve interpreting, contextualizing, and communicating AI-generated or AI-assisted information to diverse publics. The analysis is based on a qualitative review of recent academic literature, relevant policy frameworks, and selected professional practices, identifying emerging competence gaps and normative tensions at the intersection of artificial intelligence, media literacy, and strategic communication. The paper argues that strengthening communication literacy in the age of artificial intelligence is a necessary precondition for democratic resilience, social inclusion, and the sustainable development of digital public spheres. By reframing AI literacy as a communication issue rather than a purely technical skill set, the paper contributes to interdisciplinary debates on digital literacy, sustainability, and the societal impact of artificial intelligence within contemporary media systems.

Keywords: *Artificial intelligence; Communication literacy; Journalism; Public relations; Sustainable digital societies*

1. INTRODUCTION

Artificial intelligence is having a significant impact on media production, information management, and public communication, thereby reshaping professional practices in journalism and public relations. Within contemporary media and communication systems, AI can be understood as a structural factor rather than a neutral technological tool. In the context of accelerating digitalization and emerging regulatory and ethical debates, these transformations raise fundamental questions about professional responsibility, public trust, and the sustainability of democratic communication. For the purposes of this paper, artificial intelligence is approached from the perspective of communication literacy challenges, with direct implications for credibility, trust, and democratic accountability in digital societies. Drawing on recent academic literature, this paper argues that improving communication literacy regarding artificial intelligence is essential to maintaining democratic resilience, social inclusion, and the sustainable development of digital public spheres.

2. FROM TECHNOLOGICAL INNOVATION TO COMMUNICATION LITERACY

Prevailing approaches to artificial intelligence predominantly emphasize technical efficiency, automation, and economic optimization. Within such frameworks, AI is often seen as a tool to improve productivity, competitiveness, and organizational performance. As Rajko notes, in today's dynamic business environment, artificial intelligence (AI) is becoming an increasingly important tool for young entrepreneurs seeking to improve their business processes, increase efficiency, and gain a competitive advantage (Rajko, 2024: 657). Similarly, Matijašević, Baričević, and Luić argue that digital intelligence has become a key factor for achieving and sustaining digital competitiveness across various fields, including journalism (Matijašević, Baričević, and Luić, 2024: 19). From an industrial and organizational perspective, Kober, Trstenjak, Opetuk, Cajner, and Đukić highlight the growing reliance on artificial intelligence in information distribution and production processes, emphasizing cost reduction, product consistency, and human-machine collaboration. They argue that the industry is increasingly focusing on improving product consistency and reducing overall costs, which can only be achieved through successful collaboration between humans and robots (Kober et al., 2025: 669). While these perspectives provide valuable insights into the operational and economic potential of artificial intelligence, they largely overlook its broader communicative, normative, and societal implications. By prioritizing efficiency and optimization, such approaches tend to marginalize questions of meaning-making, professional responsibility, and public understanding. This paper, therefore, argues for a conceptual shift from viewing artificial intelligence solely as a technological innovation to understanding it as a communication literacy challenge, particularly within media systems that mediate public knowledge, trust, and democratic participation.

2.1. AI literacy as a form of communication literacy

In contemporary societies, the use of media and digital technologies is inseparable from communication itself. Media practices, information flows, and public discourse are increasingly shaped by technological infrastructures that mediate the production, distribution, and interpretation of meaning. In this context, Žuran and Ivanišin argue that media literacy represents a short-term actuality that requires constant development, noting that “it is expected from us to be media literate, which needs to be continually developed, actualized, and expanded, especially because the field of media technology is evolving at a fast pace” (Žuran, Ivanišin, 2013: 6, 12). Similarly, Nyikes emphasizes that the pervasive presence of information technology is often perceived as natural for younger generations, commonly referred to as digital natives. However, he cautions that “information technology or digital literacy is not an innate ability, but a skill that must be learned or acquired, since no one is born with the ability to use a spreadsheet or a word processing program” (Nyikes, 2018: 126). This distinction between exposure to technology and actual literacy is crucial for understanding contemporary communication environments. The same argument applies to artificial intelligence literacy. AI literacy cannot be reduced to mere familiarity with AI-based tools; it encompasses a critical understanding of algorithmic mediation, automated content production, data-driven narratives, and forms of human-machine collaboration within the public sphere. Individuals must learn not only how to use these technologies but also how to interpret their outputs, recognize their limitations, and apply them responsibly in communication processes. From this perspective, AI literacy constitutes a specific and increasingly important dimension of communication literacy, particularly in media systems that shape public knowledge, trust, and democratic participation.

3. ARTIFICIAL INTELLIGENCE AND JOURNALISM: EDITORIAL RESPONSIBILITY UNDER AUTOMATION

Artificial intelligence is increasingly reshaping core journalistic practices such as gatekeeping, verification, editorial judgment, and accountability. Rather than operating as a single, unified system, AI intervenes in journalism through a variety of tools and processes embedded within newsroom workflows. As Simon emphasizes, there is no single artificial intelligence involved in the gatekeeping process; instead, AI is best understood as an assemblage of different techniques, systems, and approaches, loosely grouped together under the definition outlined in the beginning, namely that these systems learn and carry out tasks that were previously thought to be reserved to humans (Simon, 2025: 14). Much of the current integration of AI in journalism focuses on automating routine and labor-intensive tasks. Verma notes that AI's role in automating routine tasks such as data collection and sorting through large volumes of information is transformative. By taking over these time-consuming tasks, AI allows journalists to devote more time and energy to the nuanced aspects of storytelling (Verma, 2024: 152). Simon similarly identifies transcription, translation, and content reformatting as some of the clearest examples of AI-driven efficiency gains in news production, describing these processes as the most common example of AI being used to drive efficiency increases (Simon, 2025: 10). While such applications offer clear organizational benefits, they also raise critical questions regarding editorial responsibility and accountability. The delegation of specific journalistic functions to algorithmic systems complicates traditional notions of professional judgment and decision-making. As Mitić observes, the essence of the problem of accountability can be explained by asking and answering the question 'Who is responsible for the use of AI?' (Mitić, 2025: 93). This question becomes particularly salient in contexts where automated systems influence content selection, prioritization, or presentation to the public. Empirical insights further underline the persistence of human responsibility within AI-augmented newsrooms. Based on a series of interviews with journalists, Lefèvre, Errando, Afilipoaie, Ranaivoso, and Wiart report that most interviewees commonly agreed that, from an organisational perspective, AI primarily enhances operational efficiency by reducing the time spent on routine tasks, though human oversight remains a key element (Lefèvre et al., 2025: 38). These findings suggest that, despite increasing levels of automation, editorial judgment and ethical accountability continue to rest with human actors rather than with technological systems themselves.

3.1. Risks, ethical standards and public trust

While automation can support data analysis and content generation, it also introduces significant risks, including automation bias, deskilling, and the loss of contextual interpretation. Ferdman observes that the acquisition of professional skills traditionally relies on mentorship and continuous practice. However, the increasing reliance on artificial intelligence may lead to situations in which automation replaces human activity, reducing individuals' opportunities to exercise judgment, responsibility, and willpower. Ferdman describes such environments as *capacity-hostile*, arguing that excessive automation can undermine the development of human competencies (Ferdman, 2025: 3, 6). From an ethical perspective, the limitations of current AI systems further complicate their use in journalism. As Mitić notes, modern AI models still do not have a sufficiently developed consciousness and moral components, we cannot expect them to independently differentiate between correct, i.e., unbiased, and incorrect, i.e., biased content. That task is still in the domain of the work of journalists (Mitić, 2025: 98). Mitić also highlights concrete risks related to privacy, stating that publishing sensitive data or inappropriate photos when distributing content is the most common example of AI-related privacy violations in the media (Mitić, 2025: 97).

Regardless of the degree of AI involvement in news production, journalism retains responsibility for meaning-making, ethical standards, and maintaining public trust. Ali and Hassoun emphasize fairness as a core ethical principle, arguing that it requires avoiding harmful biases and stereotypes that can affect people's lives. They point out that artificial intelligence poses a central challenge for journalism, particularly through its use of data to facilitate privacy intrusions, social manipulation, and forms of oppression (Ali, Hassoun, 2019: 44–45). Despite structural pressures toward speed, automation, and sensationalism, journalism continues to play a crucial role in providing citizens with relevant and reliable information. As Dahlgren argues, even within commercially and technologically driven media environments, journalism retains the potential to support informed citizenship and democratic engagement (Dahlgren, 2010: 12). Finally, the ethical and accountability challenges associated with AI in journalism are increasingly addressed within regulatory frameworks. Lefèvre, Errando, Afilipoaie, Ranaivoso, and Wiart emphasize the relevance of recent European Union legislative initiatives, noting that the **European Media Freedom Act (EMFA)** seeks to safeguard editorial independence and pluralism, the **Digital Services Act (DSA)** aims to ensure a fair and transparent online platform environment, and the **AI Act** introduces transparency and risk-management obligations for the use of artificial intelligence, including within media contexts (Lefèvre et al., 2025: 33).

4. ARTIFICIAL INTELLIGENCE AND PUBLIC RELATIONS: ALGORITHMIC PERSUASION AND STRATEGIC COMMUNICATION

Public relations constitute a distinct professional field within contemporary communication systems, oriented toward strategic messaging, relationship management, and reputation building. The increasing integration of artificial intelligence into public relations practices has significantly transformed how organizations communicate with their audiences, particularly through data-driven targeting, personalization, and automation. As Ienca observes, social media platforms rely on complex AI algorithms to determine which content users encounter, while advertisers and communicators can exploit these systems to target specific audience segments with tailored messages. This process, however, also contributes to the creation of filter bubbles, in which users are predominantly exposed to information and perspectives that reinforce their existing beliefs and values (Ienca, 2023: 838–839). In the context of public relations, such algorithmic mediation raises important questions about transparency, manipulation, and the ethical boundaries of persuasive communication. AI-driven data analytics further expand the persuasive capacities of public relations through techniques such as sentiment analysis. Ahmed, Agarwal, Kurniawan, Anantadjaya, and Krishnan describe sentiment analysis as a method for quantifying public reactions toward specific products, individuals, or ideas by examining the emotional tone embedded in digital communication. They emphasize that “sentiment analysis examines how people feel about a topic” and enables organizations to better understand audience perceptions and responses (Ahmed et al., 2022: 8). Artificial intelligence significantly enhances the efficiency and scale of such analyses, allowing communicators to continuously monitor and adapt their strategies based on real-time feedback. In addition to data analytics, AI-powered chatbots have become a prominent tool in public relations practice. Çerçi notes that chatbots enable organizations to engage instantly with their target audiences across websites, social media platforms, and mobile applications by answering questions, providing information, and solving problems. In this way, customer service and user experience are improved, and communication processes become more efficient (Çerçi, 2024: 142). Çerçi further highlights the growing use of multilingual and multicultural chatbots, which allow organizations to reach diverse audiences more effectively and to operate on a global scale. Such tools, he argues, can help organizations protect and strengthen their reputation by enabling more personalized and responsive forms of communication with their publics (Çerçi, 2024: 142).

While these applications demonstrate the strategic advantages of artificial intelligence in public relations, they also underscore the need for heightened communication literacy and ethical awareness. Algorithmic persuasion, when left unchecked, risks blurring the line between strategic communication and manipulation, particularly in digitally mediated environments characterized by asymmetric information and limited transparency. As in journalism, the responsibility for ethical decision-making, accountability, and the maintenance of public trust ultimately remains with human professionals rather than with technological systems themselves.

4.1. Ethical boundaries and manipulation

Examining ethical boundaries is essential for distinguishing between informational and persuasive communication within AI-mediated public relations practices. As artificial intelligence increasingly shapes how messages are produced, targeted, and distributed, the potential for misuse becomes a central ethical concern. Mitić argues that the problem of misuse represents the most dangerous and difficult form of violation of the ethical use of AI in media, emphasizing that the deliberate and improper application of AI can lead to serious consequences affecting both the public that consumes media content and the organizations that produce and disseminate it (Mitić, 2025: 95). One of the most visible examples of ethically problematic AI applications is deepfake technology. Ienca describes deepfakes as systems capable of manipulating a person's visual or audiovisual representation in order to create content that falsely depicts them as saying or doing something they never actually said or did (Ienca, 2023: 839). In the context of public relations, such technologies pose significant risks to trust, credibility, and reputational integrity, particularly when used for deceptive or manipulative purposes. At the same time, AI-driven tools offer clear strategic advantages for public relations professionals. Pinto and Bhadra note that artificial intelligence has enabled practitioners to focus more on strategic and creative tasks, such as advising clients, building relationships, and crafting compelling narratives, rather than on routine operational work (Pinto, Bhadra, 2024: 2146). However, they also emphasize that these tools should be applied in ways that serve broader societal interests rather than merely organizational efficiency. AI systems capable of identifying customer preferences, purchasing behaviours, and communication habits enable highly personalized messaging that can enhance brand loyalty and optimize public relations campaigns (Pinto, Bhadra, 2024: 2146). This dual potential highlights the heightened responsibility of public relations practitioners operating within AI-mediated persuasion environments. While personalization and strategic targeting can improve communication effectiveness, they also risk crossing ethical boundaries if used to exploit cognitive biases, manipulate emotions, or obscure the distinction between information and influence. From a communication literacy perspective, maintaining this distinction is essential for preserving public trust and ensuring that persuasive communication remains aligned with ethical standards and democratic values.

5. INSTITUTIONAL RESPONSIBILITY AND PROFESSIONAL MEDIATION

Journalism and public relations can be placed within a shared analytical framework by examining their institutional roles in mediating information, meaning, and trust within democratic societies. Despite differences in professional goals and practices, both fields operate at the intersection of technology, institutions, and the public, and both carry significant responsibility for shaping public understanding. As Dahlgren succinctly observes, “a cornerstone of traditional journalism has always been its commitment to truth” (Dahlgren, 2010: 13). This normative principle remains central not only to journalism but also to ethically grounded public relations practice.

Empirical research further underlines the democratic relevance of journalistic mediation. Based on interviews with journalists, Vobič reports a strong professional belief that news media function as a key resource for citizens' decision-making and participation. One interviewee emphasizes this role by stating: "People can read on our website that 'this-and-that' happened and can make an informed opinion on this basis. We help the citizens not to turn into a flock of sheep" (Vobič, 2011: 63). Such statements reflect a persistent understanding of journalism as an institutional actor contributing to informed citizenship. In a more recent study, Vobič, Robnik Šikonja, Žagar, and Mance link news diversity to two processes crucial for shaping the democratic public sphere. They argue that pluralization and homogenization function together as complementary mechanisms: normatively, pluralization refers to the articulation of ideas and interests of diverse social groups, including marginalized ones, within a rational and well-argued public debate, while a certain level of homogenization of shared issues is necessary to facilitate public discourse, opinion formation, and political participation (Vobič et al., 2025: 6). These processes are increasingly influenced by algorithmic systems that affect content visibility, prioritization, and distribution. The institutional challenges faced by journalism are mirrored, in a different form, within public relations. Gencil Bek's research on Turkish journalism highlights persistent tensions between news and commentary, noting that while newspapers in every country tend to reflect political orientations, the distinction between factual reporting and opinion is not always clearly maintained (Gencil Bek, 2011: 171). Such blurring becomes particularly problematic in AI-mediated environments, where automated systems may further obscure editorial boundaries. Ethical responsibility is equally central to public relations, especially in contexts of crisis communication. Janeš and Čendo Metzinger emphasize that trust in the competence and moral integrity of PR practitioners is a prerequisite for effective communication, warning that any misuse or manipulation of key information will affect the credibility of the communicator, and thus the success of the communication process (Janeš, Čendo Metzinger, 2018: 154). Transparency therefore becomes a fundamental professional obligation. In this regard, Mitić explicitly states that if the entire content is generated by AI then it should be clearly indicated to distinguish it from other content (Mitić, 2025: 94). Taken together, these perspectives underscore the role of journalists and public relations practitioners as key intermediaries between technologies, institutions, and citizens. Their responsibilities extend beyond operational efficiency and technological proficiency to include interpretation, contextualization, and the ethical communication of AI-generated or AI-assisted information. In AI-driven communication environments, professional mediation, transparency, accountability, and the maintenance of democratic standards emerge as central normative requirements for both fields.

6. COMMUNICATION LITERACY, TRUST AND DEMOCRATIC SUSTAINABILITY

Communication literacy in the age of artificial intelligence emerges as a crucial precondition for democratic resilience, social inclusion, and the sustainability of digital public spheres. As AI systems increasingly mediate the production, distribution, and interpretation of information, the ability of professionals and citizens to critically understand and contextualize algorithmic processes becomes central to maintaining public trust and democratic accountability. Lefèvre, Errando, Afilipoaie, Ranaivoso, and Wiart outline a set of recommendations for the ethical integration of artificial intelligence in the news media sector. These include the adoption of transparent practices in content creation and distribution, the promotion of collaborative self-regulation initiatives among media organizations, the implementation of comprehensive training programs aimed at enhancing AI literacy among media professionals, and the establishment of robust oversight mechanisms and accountability standards to monitor AI applications within media institutions (Lefèvre et al., 2025: 48).

Such measures highlight the institutional dimension of communication literacy as a shared responsibility rather than an individual skill. The importance of continuous education is equally emphasized in the field of public relations. Galloway and Swiatek argue that education, whether self-initiated or institutionally supported, is essential for enabling public relations practitioners to remain informed about ongoing technological developments. In the short term, they suggest that practitioners should seek targeted training focused on the key aspects and applications of artificial intelligence (Galloway, Swiatek, 2018: 736). At the same time, they caution that public relations professionals do not need to become expert technologists. Instead, they should develop a sufficient and critical understanding of AI and related technologies to provide informed, responsible, and workable advice to clients (Galloway, Swiatek, 2018: 736). Taken together, these perspectives reinforce the central argument of this paper: strengthening communication literacy in relation to artificial intelligence is not merely a technical or professional requirement, but a normative condition for sustaining trust, transparency, and democratic values in digitally mediated societies. By framing AI literacy as an integral component of communication literacy, this paper underscores the need for coordinated efforts across journalism, public relations, education, and policy-making to ensure that artificial intelligence contributes to, rather than undermines, the democratic sustainability of contemporary media systems.

7. CONCLUSION

Artificial intelligence should be understood as a communicative and institutional challenge rather than a purely technical innovation. While AI can enhance practices such as personalization, audience targeting, and operational efficiency, its integration into journalism and public relations fundamentally reshapes how information is produced, interpreted, and communicated within digital societies. Strengthening communication literacy among media professionals emerges as a key condition for preserving the legitimacy, credibility, and social relevance of journalism, public relations, and public communication. Achieving this level of literacy in the age of artificial intelligence requires not only individual skills, but also clearly defined professional standards, institutional frameworks, and ethical guidelines that govern the use of AI in media and strategic communication. Particular attention must be paid to the ethical boundaries between legitimate strategic communication and manipulation, especially in AI-mediated environments characterized by automation, personalization, and algorithmic persuasion. In this context, truth, transparency, and accountability remain foundational values. Upholding these principles is essential for maintaining public trust and for ensuring that artificial intelligence contributes to democratic resilience and the sustainable development of digital public spheres rather than undermining them.

LITERATURE:

1. Ahmed, A. A. A., Agarwal, S., Kurniawan, I. G. A., Anantadjaya, S. P., & Krishnan, C. (2022). Business boosting through sentiment analysis using an artificial intelligence approach. *International Journal of System Assurance Engineering and Management*, 13, 1–11. Retrieved 20.2.2026 from <https://repository.ipmi.ac.id/2086/1/38b0b726-4611-Business%20Boosting-Springer.pdf>.
2. Ali, W., & Hassoun, M. (2019). Artificial intelligence and automated journalism: Contemporary challenges and new opportunities. *International Journal of Media, Journalism and Mass Communications*, 5(1), 40–49. Retrieved 20.2.2026 from <https://www.arcjournals.org/pdfs/ijmjm/v5-i1/4.pdf>.
3. Çerçi, Ü. Ö. (2024). An innovative communication paradigm for the future of public relations: Artificial intelligence. *Türkiye İletişim Araştırmaları Dergisi*, 128–147. Retrieved 20.2.2026 from <https://dergipark.org.tr/en/pub/turcom/article/1360264>.

4. Dahlgren, P. (2010). Charting the evolution of journalism: The horizon of democracy. *Medijske studije*, 1(1–2), 3–17. Retrieved 20.2.2026 from <https://hrcak.srce.hr/76698>.
5. Erceg Matijašević, I., Baričević Debelec, M., & Luić, Lj. (2024). Assessing sentiments towards artificial intelligence in the Croatian media using the ChatGPT artificial intelligence tool. *Medijska istraživanja*, 30(2), 5–30. <https://doi.org/10.22572/mi.30.2.1>.
6. Ferdman, A. (2025). AI deskilling is a structural problem. *AI & Society*, 1–13. Retrieved 20.2.2026 from <https://link.springer.com/content/pdf/10.1007/s00146-025-02686-z.pdf>.
7. Galloway, C., & Swiatek, L. (2018). Public relations and artificial intelligence: It's not (just) about robots. *Public Relations Review*, 44(5), 734–740. Retrieved 20.2.2026 from https://membership.culturalinfusion.com/wp-content/uploads/2023/08/2018-Public-relations-and-artificial-intelligence_-Its-not-just-about-robots.pdf.
8. Gencil Bek, M. (2011). Turkish and international journalists comparing the media systems, journalistic practices and news production processes. *Medijska istraživanja*, 17(1–2), 163–176. Retrieved 20.2.2026 from <https://hrcak.srce.hr/80508>.
9. Ienca, M. (2023). On artificial intelligence and manipulation. *Topoi*, 42, 833–842. Retrieved 20.2.2026 from <https://link.springer.com/article/10.1007/s11245-023-09940-3>.
10. Janeš, H., & Čendo Metzinger, T. (2018). Management of communication processes in crisis situations. *Annals of Disaster Risk Sciences*, 1(2), 151–155. Retrieved 20.2.2026 from <https://hrcak.srce.hr/212765>.
11. Kober, H., Trstenjak, M., Opetuk, T., Cajner, H., & Đukić, G. (2025). Artificial intelligence system for the digitalization of information distribution. *Tehnički glasnik*, 19(4), 669–677. <https://doi.org/10.31803/tg-20240523123116>.
12. Lefèvre, B., Errando, A., Afilipoaie, A., Ranaivoso, H., & Wiart, L. (2025). Exploring ethical and regulatory challenges of AI integration in European Union newsrooms. *Medijske studije*, 16(31), 31–55. <https://doi.org/10.20901/ms.16.31.2>.
13. Mitić, A. (2025). Between Scylla and Charybdis: A categorization of ethical challenges associated with the use of artificial intelligence in the media. *Medijske studije*, 16(32), 89–105. <https://doi.org/10.20901/ms.16.32.5>.
14. Nyikes, Z. (2018). Contemporary digital competency review. *Interdisciplinary Description of Complex Systems*, 16(1), 124–131. <https://doi.org/10.7906/indec.16.1.9>.
15. Pinto, R., & Bhadra, A. (2024). Smarter public relations with artificial intelligence: Leveraging technology for effective communication strategies and reputation management – A qualitative analysis. *REDVET – Revista Electrónica de Veterinaria*, 25(1). Retrieved 20.2.2026 from https://www.researchgate.net/profile/Abhirup-Bhadra-2/publication/384609483_Smarter_Public_Relations_with_Artificial_Intelligence_Leveraging_Technology_for_Effective_Communication_Strategies_and_Reputation_Management-A_Qualitative_Analysis.
16. Rajko, M. (2024). The use of artificial intelligence by young entrepreneurs in the Republic of Croatia. *Interdisciplinary Description of Complex Systems*, 22(6), 656–665. <https://doi.org/10.7906/indec.22.6.2>.
17. Simon, F. M. (2025). Rationalisation of the news: How AI reshapes and retools the gatekeeping processes of news organisations in the United Kingdom, United States and Germany. *New Media & Society*. Retrieved 20.2.2026 from <https://journals.sagepub.com/doi/pdf/10.1177/14614448251336423>.
18. Verma, D. (2024). Impact of artificial intelligence on journalism: A comprehensive review of AI in journalism. *Journal of Communication and Management*, 3(2), 150–156. <https://doi.org/10.58966/JCM20243212>.

19. Vobič, I. (2011). Societal roles of journalism in the age of the Internet and digital television: Slovenian online journalists and their self-perceptions. *Medijska istraživanja*, 17(1–2), 53–73. Retrieved 20.2.2026 from <https://hrcak.srce.hr/80471>.
20. Vobič, I., Robnik Šikonja, M., Žagar, A., & Mance, B. (2025). Watchdog or copycat? Examining news diversity in the Slovenian journalism system. *Medijska istraživanja*, 31(2), 5–30. <https://doi.org/10.22572/mi.30.2.1>.
21. Žuran, K., & Ivanišin, M. (2013). Media literacy in times of media divides. *Medijske studije*, 4(8), 3–15. Retrieved 20.2.2026 from <https://hrcak.srce.hr/118036>.

REMOVAL OF A MEMBER OF THE MANAGEMENT BOARD (DIRECTOR) OF A LIMITED LIABILITY COMPANY: STATUS- RELATED LEGAL ASPECTS AND METHODS OF INTERPRETATION

Ratko Brnabic

*University of Split/Faculty of Law in Split
Domovinskog rata 8, Split, Croatia
rbrnabic@pravst.hr*

Zaklina Harasic

*University of Split/Faculty of Law in Split
Domovinskog rata 8, Split, Croatia
zharasic@pravst.hr*

ABSTRACT

In limited liability companies, shareholders, as a rule, appoint and remove the members of the management board (directors). Pursuant to the Croatian Companies Act, a director may be removed from office at any time, without the need to state reasons, by a simple majority of the votes cast by the shareholders, unless the articles of association provide otherwise. A practically identical regulatory approach to this issue can be found in the comparable company law regimes of Germany and Austria. This ensures that shareholders are able to remove the management in the event of a loss of confidence, thereby counterbalancing the broad powers vested in directors with respect to the management of the company's affairs and its representation. However, in situations involving a conflict between shareholders, particularly where one shareholder (whether a majority shareholder or a 50% shareholder) protects its external director (i.e. a director who is not himself or herself a shareholder of the company) and refuses to vote in favour of his or her removal, a serious corporate governance problem arises. A minority shareholder or an equal (50%) shareholder who considers that the director is acting contrary to the interests of the company (for example, on the basis of informal instructions issued by the majority shareholder) does not hold a sufficient number of votes to pass a resolution on removal independently at the general meeting. Such a shareholder therefore seeks mechanisms to remove the director despite the obstruction by the other shareholder. One of the key elements and preconditions for removal is the existence of good cause. Good cause constitutes a statutory legal standard justifying the compulsory removal of a director, particularly where contractual limitations exist or where the removal is effected by a court. As expected, the legislature has left the substantive content of this standard to judicial practice and legal doctrine. The paper first addresses the internal (autonomous) mechanisms within the company for the removal of directors and subsequently examines the legal remedies available before the courts under Croatian law where a shareholder holding a minority or 50% stake cannot secure a resolution on removal at the general meeting. Practice has shown that competent courts frequently adopt divergent positions and lines of reasoning with respect to the removal of directors; accordingly, part of the discussion concerning the right of removal extends to questions relating to the interpretation of norms belonging to a distinct legal discipline – the theory of state and law. An analysis of judicial reasoning from the perspective of the theory of state and law provides guidance for the application of the relevant norms. Comparative legal solutions under German and Austrian company law are also considered.

Keywords: *removal of management board member; LLC management board; good cause; general meeting; shareholder-director*

1. INTRODUCTION

In limited liability companies the general rule is that the members of the company may remove the director (member of the management board) at any time and without stating reasons.¹ This default rule serves to establish a counterbalance to the virtually unlimited authority of the director to represent the company.² The principle of free removal is an expression of the subordination relationship between the management board and the general meeting – a director may exercise his function only as long as he enjoys the confidence of the members of the company.³ Accordingly, the Companies Act (hereinafter: CA) provides that the members may remove the director of a limited liability company at any time (ex nunc) by a simple majority of votes, without special formalities or an obligation to state reasons.⁴ This applies equally to a director who is simultaneously a member of the company and to an “external” (non-member) director. In this manner, the company protects its security against potentially undesirable management: free removal constitutes a counterbalance to the unlimited representative authority of the director and a supplement to the right of the general meeting to issue binding instructions to directors.⁵ Comparatively, German law likewise prescribes the right to remove a director at any time, since the director’s status in a limited liability company depends on the confidence of its members (holders of business shares).⁶ In contrast to a joint-stock company (where removal of a member of the management board is permissible only for good cause, Art. 244(2) CA; § 84(4) AktG), in a limited liability company removal is, in principle, unrestricted (good cause is not required for removal) precisely because of the particularly close relationship between the members and the management board.⁷

A particular challenge for legal practice arises in cases of two-member companies where the members hold equal or marginally different shares and one member (the majority holder or holder of 50%) refuses to remove the director, despite the other member suspecting that the director acts pursuant to secret instructions of that member, contrary to the interests of the company. Most frequently, this will involve situations where the director sells company assets below market value, justifying this by the need for urgent liquidation. Simultaneously, there is suspicion that the director does so under the covert influence of a “protector” – a member of the company who supports him. The other member (the minority holder or likewise holder of 50%) wishes to remove the director in order to protect the company. However, without the consent of the majority (or the other 50%) member, they formally cannot achieve the requisite majority of votes for a decision on the removal of the director at the general meeting of the company. This creates a decision-making deadlock, as the member with control or half of the votes protects “their” director, while the dissatisfied member, as a rule, lacks an internal legal mechanism to dismiss the director, despite indications pointing to his detrimental conduct.

¹ Gorenc, V.; Ćesić, Z.; Buljan, V.; Brkanić, V., *Komentar Zakona o trgovačkim društvima*, RRiF-plus, Zagreb 2008, pp. 1020, 1022.

² Brnabić, R., *Opoziv člana uprave društva s ograničenom odgovornošću*, *Pravo u gospodarstvu*, vol. 56, 3/2017, p. 432.

³ *Ibid.*, p. 433.

⁴ Gorenc, V. *et al.*, *op. cit.* in fn. 1, p. 1022. Cf. Rowedder, H.; Schmidt-Leithoff, C. (eds.), *Gesetz betreffend die Gesellschaften mit beschränkter Haftung (GmbHG): Kommentar*, 6th ed., Vahlen, München 2017, § 38, paras. 1–2.

⁵ Brnabić, R., *op. cit.* in fn. 2, pp. 431–433.

⁶ Kleindiek, D., in: Bayer, W.; Hommelhoff, P.; Kleindiek, D. (eds.), *GmbH-Gesetz: Kommentar*, 21st ed., Verlag Dr. Otto Schmidt, Köln 2023, § 38, paras. 1–3. See also Schneider, U. H.; Schneider, S. H., in: Scholz, F. (founder), *Kommentar zum GmbH-Gesetz*, vol. II, 12th ed., Verlag Dr. Otto Schmidt, Köln 2021, § 38, paras. 12–14.

⁷ Brnabić, R., *op. cit.* in fn. 2, pp. 434–435.

2. AUTONOMOUS REGULATION OF DIRECTOR'S REMOVAL

Although the Law permits removal of the director without stating reasons, the members of the company may autonomously regulate the manner of appointment and removal of the management board in the articles of association. The articles of association may provide for a different allocation of competence for removal: for example, they may stipulate that the supervisory board (if one exists) appoints and removes members of the management board instead of the general meeting, or they may even designate a particular member of the company or another body as having that right.⁸ As a general rule, the authority to remove belongs to whoever has the authority to appoint, unless otherwise provided by the articles of association.⁹ Furthermore, Art. 424(1) CA permits the founding act to separate the powers of appointment and removal – for example, having one body perform the appointment and another perform the removal.¹⁰ It is not, however, permissible to confer the right of removal upon a completely external third person who is not part of any corporate body; such a person would need to be formally integrated as a body in order to possess that authority.¹¹ In practice, for smaller limited liability companies, it is customary for the general meeting to retain the right of appointment and removal of the director, but it is important to note that this is not an absolutely immutable rule, but rather one subject to the autonomy of the company's members. The articles of association may also restrict the right to removal – for example, by prescribing a qualified majority of votes or by extending the scope of the good cause requirement for removal. The Companies Act does not expressly prohibit such a restriction; indeed, it indicates the default nature of the rules on free removal.¹² German law expressly permits the articles of association of a GmbH to restrict removal to cases where good cause exists (§ 38(2) GmbHG).¹³ The same applies in Austria, with the proviso that the Austrian GmbHG § 16(3) relates primarily to directors who are also members of the company.¹⁴ In Croatia, such a statutory clause would be of a default nature – it is legally valid and binding for the relations among the members, but cannot derogate from the general right of the members to remove the company's director. It should be noted that even if the articles of association or a management agreement restrict the members' right to free removal (e.g., by requiring good cause), a valid decision on removal may nevertheless be adopted at any time and without stating reasons.¹⁵ In other words, such a contractual restriction has effect in the sphere of contractual (obligational) relations (e.g., the director could claim damages for breach of contract), but does not prevent the corporate act of removal itself.¹⁶ This reflects the general rule on the separation of the organisational position of the director and his contract with the company: removal is a unilateral act of the company that terminates the director's organisational status, while the management services agreement remains separately valid until its eventual termination.¹⁷ Removal from office does not *ipso iure* terminate the managerial contract, which requires a separate legal act (such as termination of the contract).¹⁸

⁸ Gorenc, V. *et al.*, *op. cit.* in fn. 1, pp. 1021–1022.

⁹ Brnabić, R., *op. cit.* in fn. 2, p. 435. Cf. Kleindiek, D., *op. cit.* in fn. 6, § 38, paras. 3–6.

¹⁰ Gorenc, V. *et al.*, *op. cit.* in fn. 1, pp. 1021–1022.

¹¹ Kleindiek, D., *op. cit.* in fn. 6, § 38, paras. 7–8.

¹² Brnabić, R., *op. cit.* in fn. 2, pp. 436–437.

¹³ Oetker, H., in: Henssler, M.; Strohn, L. (eds.), *Gesellschaftsrecht*, 6th ed., C.H. Beck, München 2024, § 38, paras. 20–21.

¹⁴ Arnold, N.; Pampel, F.-R., in: Gruber, M.; Harrer, F. (eds.), *GmbHG: Kommentar*, 2nd ed., Linde Verlag, Wien 2018, § 16, paras. 1–10.

¹⁵ Gorenc, V. *et al.*, *op. cit.* in fn. 1, p. 1025.

¹⁶ Arnold, N.; Pampel, F.-R., *op. cit.* in fn. 14, p. 1025.

¹⁷ Oetker, H., *op. cit.* in fn. 13, § 38, paras. 66, 68.

¹⁸ Brnabić, R., *op. cit.* in fn. 2, pp. 438–439.

Nevertheless, the company and the director may contractually stipulate the contrary – e.g., by a clause providing that removal automatically terminates the employment/management contract as well – since this is a matter of contractual autonomy.¹⁹ In practice, coupling clauses that tie the duration of the contract to continued tenure in office are common, in order to avoid the “dual authority” of a removed director who formally still has a contract.²⁰ It is important to emphasise that the articles of association cannot entirely exclude removal for good cause. In principle, a provision that would exclude the company’s right to remove a member of the management board for good cause, or that would exhaustively enumerate the grounds and thereby preclude removal in other situations that objectively constitute good cause, is void.²¹ Good cause for removal is considered an inseparable protective mechanism of the company: it may not be derogated in advance nor restricted beyond the extent that would prevent a justified dismissal of the director.²² While it is thus possible to make the conditions for removal more stringent by contract (e.g., requiring a qualified majority of votes or requiring formal good cause to exist), it is not permissible to completely preclude the removal of the director when justified grounds exist. This concerns the inalienable right of a company to remove a director whenever good cause exists, regardless of the provisions of the articles of association.²³ Therefore, even a director who enjoys a special right to hold office under the articles of association (e.g., a member of the company whose right to serve as director is guaranteed by the founding act) cannot remain in office if good cause for his removal arises.²⁴ In the case of such a statutorily guaranteed position, removal from office is possible through an amendment to the articles of association (with the consent of the rights holder), but also by court decision if good cause can be demonstrated (pursuant to Art. 424(2) CA). In any event, it is clear that a special right to serve as director cannot be abused for conduct detrimental to the company – nor may the articles of association preclude removal when grounds exist that objectively render the director’s continued tenure unreasonable.²⁵ In our factual scenario, the articles of association will determine whether a simple or qualified majority is required for the removal of the director and whether any restriction exists. We shall assume that the articles of association did not provide for special deadlock-resolution mechanisms (e.g., no casting vote, arbitrator, or similar mechanism was stipulated), nor that the director has the status of a “special right” of a member of the company. Accordingly, the statutory regime applies: the general meeting may remove the director by a simple majority of votes *cast*.²⁶ In a two-member company with equal shares, this practically means that the consent of both members is required, because otherwise the ratio of votes is equal, and the requisite majority of votes for the adoption of the decision is not achieved. Given that one member refuses to vote in favour of removal, the general meeting cannot adopt a resolution on dismissal. As a rule, nothing will be achieved through attempts to persuade the majority member to change his position or by convening a new general meeting. For these reasons, the member of the company who is dissatisfied with the management is left with legal mechanisms that do not depend on the autonomous regulation of the legal relations among the members, which will be discussed below.

¹⁹ Barbić, J., *Pravo društava*, Book Two: Društva kapitala, Volume 2: Društvo s ograničenom odgovornošću, 8th ed., Organizator, Zagreb 2025, p. 440.

²⁰ Oetker, H., *op. cit.* in fn. 13, § 38, paras. 68–69.

²¹ Barbić, J., *op. cit.* in fn. 19, p. 439.

²² Heilmeier, M., in: Ziemons, H.; Jaeger, C.; Pöschke, M. (eds.), *BeckOK GmbHG*, 66th ed., C.H. Beck, München 2024, § 38, para. 20. Cf. Beurskens, M., in: Noack, U.; Servatius, W.; Haas, U. (eds.), *GmbH-Gesetz*, 24th ed., C.H. Beck, München 2025, § 38, para. 5.

²³ Beurskens, M., *op. cit.* in fn. 22, § 38, para. 5.

²⁴ Barbić, J., *op. cit.* in fn. 19, pp. 386 and 440.

²⁵ Heilmeier, M., *op. cit.* in fn. 22, § 38, para. 20.

²⁶ Gorenc, V. *et al.*, *op. cit.* in fn. 1, p. 1022.

3. REMOVAL OF THE DIRECTOR

The CA in Article 424 provides for two key mechanisms for judicial intervention where the general meeting cannot or will not remove the director despite the existence of good cause. The first is a direct action for removal of the director by way of court proceedings (paragraph 2), and the second is an action for the granting of consent for removal against the member of the company who refused to do so (paragraph 3). For both avenues, the precondition is that good cause for the dismissal of the director in question exists.²⁷ In this manner, the court prevents abuse – the court will not intervene in the internal sphere of the company’s governance absent a serious occasion. Any member of the company (regardless of the size of their share) is authorised to file an action with the commercial court for the removal of a member of the management board if good cause exists (Art. 424(2)). In such proceedings, the court establishes whether good cause justifying dismissal exists. If it finds that such cause exists, the court will remove the director by judgment.²⁸ A judgment by which the court removes a member of the management board has the same effect as a general meeting resolution on removal – the organisational status of the director ceases upon the judgment becoming final. In the described scenario, the minority member could directly sue for the dismissal of the director, citing as good cause, for example, a serious breach of duty (selling assets below market price contrary to the interests of the company) or loss of confidence due to justified suspicion of collusion between the director and the majority member to the detriment of the company. The procedure is adversarial; the defendant is formally the company (or the members who supported the director – see below), and the dispute concerns the justification of the removal. The court must, as a preliminary question, examine in full all circumstances relevant to good cause. If the cause is confirmed, the court renders a constitutive decision on removal. Such an action is particularly practical where the management (or the majority member) refuses even to convene a general meeting, or where it is clear that the general meeting majority would never dismiss a director causing harm to the company. In Austrian company law, the possibility of an action for removal has likewise been introduced.²⁹ In contrast to Germany (where, in such a case, the member-director is excluded from voting, enabling the remaining members to dismiss him by simple majority),³⁰ in Austria³¹ and Croatia it was necessary to ensure express judicial intervention. The second mechanism targets the situation where a vote has taken place but the decision was not adopted because certain member(s) of the company did not cast their vote in favour of removal. In that case, the member who voted (or wished to vote) for removal may file an action against those members who refused to give consent, requesting the court to order them to consent to the removal (the so-called action for consent to removal pursuant to Art. 424(3)). The claim requests that the court decision substitute the missing vote for the removal of a particular director. In such proceedings, the court will likewise first establish whether good cause for the dismissal exists – absent such cause, the action is dismissed. If it finds good cause, the court will grant the claim by judgment, and it will thereby be deemed that the consent of the members who refused removal has been given. The effects are practically identical to those that would have occurred had the general meeting adopted the decision by the requisite majority. The judgment substitutes the vote of the dissenting member of the company. The consent is deemed given on the date the court decision, ordering the member to grant it, becomes final.

²⁷ Barbić, J., op. cit. in fn. 19, pp. 437–438.

²⁸ Ibid., p. 438.

²⁹ Arnold, N.; Pampel, F.-R., op. cit. in fn. 14, § 16, para. 4.

³⁰ Stephan, K.; Tieves, J., in: Fleischer, H.; Goette, W. (eds.), *Münchener Kommentar zum Gesetz betreffend die Gesellschaften mit beschränkter Haftung (GmbHG)*, vol. II, 4th ed., C.H. Beck, München 2023, § 38, para. 29.

³¹ Arnold, N.; Pampel, F.-R., op. cit. in fn. 14, § 16, para. 2.

The court is obliged to notify the director himself (even if he is not formally a party) of such proceedings, so that he too may protect his interests in the proceedings.³² In practice, the action for consent is of great significance for two-member companies, particularly in cases where one member systematically blocks the decision on removal. In principle, every member of the company has a duty of loyalty towards the company and the other members, which includes the obligation to vote in favour of the removal of a director if good cause exists.³³ The failure to fulfil this obligation constitutes a breach of the member's duty, on account of which the court may intervene and "compulsorily" provide the vote necessary for the removal. The High Commercial Court of the Republic of Croatia has taken the position that a member of the company who refuses to vote for removal despite the existence of good cause is abusing their right, which justifies judicial intervention for the protection of the company. In other words, it is in the interest of the company that the removal be carried out if good cause exists, and the minority member must not be outvoted by the majority to the detriment of the company. In this way, the court decision rectifies the situation of a "voting deadlock" and prevents the company from suffering due to unfounded protection of a poor director. In the case at hand, the minority member (or the 50-percent co-partner) could, by means of this action, request the court to order the majority member to give consent for the removal of the director. If the court finds that the director's management (e.g., selling off assets at well below value to related persons) is contrary to the interests of the company and constitutes good cause, it will grant the claim.³⁴ This would result in the director's dismissal despite the objection of the majority member. (Note: In practice, both actions – the direct one for removal and the one for consent – could often be asserted in the alternative, but Art. 424(3) CA specifically governs this second option.)

It should be added that the judicial removal procedure is of an urgent nature. The company or the authorised member may propose that the court issue an interim measure already during the litigation, in order to protect the interests of the company while the dispute is pending. Indeed, if the director continues to hold office, there is a risk of further detrimental actions (in our case, continued selling of assets below price or misappropriation of funds). The court may issue an interim measure prohibiting the director from performing his duties until the conclusion of the removal proceedings, if the plaintiff makes it probable that good cause exists and that the company would suffer irreparable harm if the director's mandate continues.³⁵ Additionally, an individual member of the company may obtain a court-ordered prohibition (temporary deprivation of authority) against the director for the period until all members decide on the removal,³⁶ particularly where it has become apparent that further cooperation with the director is no longer possible.³⁷ In our situation, the minority member could, immediately upon commencing the dispute, seek such a measure: for example, a prohibition against the director from undertaking extraordinary transactions (such as the sale of key assets) and a prohibition against representing the company until the conclusion of the proceedings. The court would assess the urgency and the probability of the grounds – for instance, the fact that the director has already sold part of the assets significantly below price, pointing to gross untrustworthiness or harmful intent – and could order a measure to prevent irreparable harm. Naturally, an interim measure does not prejudge the outcome of the main dispute, but it has a preventive effect.

³² Barbić, J., *op. cit.* in fn. 19, p. 437.

³³ Brnabić, R., *op. cit.* in fn. 2, pp. 443–444.

³⁴ Barbić, J., *op. cit.* in fn. 19, pp. 436–438.

³⁵ *Ibid.*, p. 438.

³⁶ Kleindiek, D., *op. cit.* in fn. 6, § 38, paras. 36–38.

³⁷ Lenz, J.; Römermann, V. (eds.), *Münchener Anwaltshandbuch GmbH-Recht*, 5th ed., C.H. Beck, München 2023, § 8, para. 34.

It “freezes” the director’s powers pending the decision on removal, thereby protecting the company from further risky actions.³⁸ In practice, the director may be replaced by a temporary administrator appointed by the court (ex Art. 424a CA, if none of the authorised persons can manage the affairs), but this is an extreme measure if the company is left without management. In a two-member company where another director exists, a temporary administrator will not be necessary – it is sufficient to suspend the contested director. Summary of judicial mechanisms: Judicial participation in the removal of a director ensures that neither can the majority member abuse the right to vote and protect “their” director to the detriment of the company, nor is the minority member left without protection. Judicial removal is a corrective of corporate democracy: it intervenes only when internal mechanisms fail. It is important that a high threshold of proof – good cause – is required for judicial dismissal or compulsory removal, in order to prevent the court from acting on subjective or trivial disagreements. In the next chapter, we shall examine in greater detail the concept of “good cause” in this context.

3.1. Concept of “Good Cause” for the Removal of a Director

Good cause represents a key legal standard in situations where it is essential for the removal of the director that the director has violated rules through his conduct. Good cause exists whenever the continuation of the mandate of that person at the head of the company cannot reasonably be expected.³⁹ The Croatian CA does not enumerate the grounds exhaustively but rather leaves it to judicial practice to fill in this standard, which implies that a need for judicial assessment of good cause will frequently arise.⁴⁰ Doctrine and case law have, nonetheless, provided a definition: good cause exists where the circumstances are such that an irreversible loss of confidence has occurred and cooperation between the director and the company (or its members) is no longer possible. In the assessment, all circumstances of the case are to be taken into account, primarily the interests of the company, but the interests of the director in question are not to be entirely disregarded either.⁴¹

It is important to emphasise that the existence of good cause does not necessarily presuppose unlawfulness or fault on the part of the director. In other words, the director need not have violated the law or contractual obligations, nor must the company have suffered loss, for justified grounds for dismissal to exist. Even conduct that cannot formally be “reproached” to the director – for example, persistent disagreement with other members of the management board in the conduct of business affairs – may reach the threshold of good cause if it prevents the normal functioning of the management board. Similarly, circumstances of a personal nature may constitute good cause: for example, an incurable illness or loss of working capacity of the director, even though there is neither a breach of duty nor fault on his part. German doctrine emphasises that the grounds need not be exclusively personal to the director; they may also be external, such as loss of confidence by key business partners in the director, a dramatic decline in business requiring a change in leadership, organisational changes (mergers, restructuring) rendering the director’s position superfluous, and the like.⁴² What is essential is that, in the overall assessment, the continuation of the director’s mandate poses a risk or obstacle to the company. Case law insists on a comprehensive weighing of all circumstances, taking into account the duration of the previous mandate, the director’s prior proper conduct, and his potential merits for the company.

³⁸ Lenz, J.; Römermann, V., *op. cit.* in fn. 37, § 8, para. 34.

³⁹ Barbić, J., *op. cit.* in fn. 19, p. 440. See also Heilmeyer, M., *op. cit.* in fn. 22, § 38, paras. 20–28.

⁴⁰ Brnabić, R., *op. cit.* in fn. 2, pp. 445–446.

⁴¹ Barbić, J., *op. cit.* in fn. 19, p. 440.

⁴² Lenz, J.; Römermann, V., *op. cit.* in fn. 37, § 8, para. 37.

If the director has successfully managed the company for a long period, that capital of trust will not be easily lost on account of a single incident of minor significance.⁴³ On the other hand, in the case of smaller, personally oriented companies, the courts are more inclined to accept the premise that mutual trust between the director and the members is essential, and consequently even lesser incidents may be viewed more seriously if they have undermined that trust within a small community.⁴⁴

Examples of good cause include accepting bribes, improper (unconscionable) performance of duties, falsification of documents, serious breach of the principle of trust, persistently disrupted relations and incompatibility within the management board, the director acting contrary to binding instructions of the company's bodies or owners, over-indebtedness of the company (caused by the director), loss of key markets or partners due to the director, serious illness or loss of capacity.⁴⁵ German case law also cites gross breaches of duty (any violation of the law or of obligations towards the company reaching a certain degree of gravity), incapacity for the proper conduct of business (whether due to ignorance, lack of expertise, negligence, or justified reasons such as illness or even prolonged imprisonment), inappropriate behaviour damaging the company's reputation or relations with clients, repeated minor transgressions, and serious disruption of trust between the director and other bodies or members (e.g., open conflicts with the supervisory board or co-owners).⁴⁶

The key element is proportionality: the court (or the general meeting) must assess whether trust and cooperation with the director can still be maintained through milder means, or whether dismissal is the only reasonable option for the protection of the company.⁴⁷ This is significant for the case under consideration: here the director sells assets below price under suspicious circumstances. Although he may formally contend that no law was violated (perhaps he has the general meeting's approval for the sale of assets, or the assets were not subject to restrictions), the fact that he does so with obvious detriment to the company and without reasonable commercial justification is a strong indicator of a breach of fiduciary duty. If this is further connected with evidence (or at least indications) that the buyer of the assets is related to or favoured by the majority member – a conflict of interest and unconscionable conduct are clearly delineated. Such conduct may very well be qualified as good cause: it constitutes a gross breach of the director's duty of loyalty towards the company (as it favours the concealed interest of the majority member to the detriment of the company). Even if there were no evidence of a corrupt arrangement, the mere fact that the director continuously makes *objectively detrimental business decisions* (selling below price) is sufficient to destroy confidence in his ability and willingness to act in the interest of the company. In this sense, "business decisions" of the director that are not prohibited by law, yet are economically highly questionable and systematically detrimental, may constitute good cause. The line is drawn where it is reasonable to state: no responsible owner would leave such a person at the helm of their business.

Specifically, selling assets below market value is frequently cited as an example of a possible breach of the director's duty of care and loyalty. If the director cannot provide an objective justification (e.g., that the company faced imminent insolvency and a "forced sale" was necessary – which does not appear to be the case here, particularly if the assets are being sold to related parties), such conduct indicates abuse of position.

⁴³ Heilmeier, M., op. cit. in fn. 22, § 38, paras. 22–26.

⁴⁴ Oetker, H., op. cit. in fn. 13, § 38, paras. 35–36.

⁴⁵ Barbić, J., op. cit. in fn. 19, pp. 440–441.

⁴⁶ Heilmeier, M., op. cit. in fn. 22, § 38, paras. 20–22.

⁴⁷ Oetker, H., op. cit. in fn. 13, § 38, paras. 10–12.

Moreover, the suspicion that the director acts pursuant to someone's covert instructions (the so-called *covert tutelage* of the majority member) falls into the category of de facto management contrary to the director's duty to conduct business independently and in the interest of all members. Even German literature acknowledges that resistance by the director to improper interventions by the general meeting or the owners must exist, which is why the director is afforded security of tenure; however, conversely, if a director blindly follows the instructions of one member to the detriment of the company, this constitutes a breach of duty towards the company.⁴⁸ This may be paradoxically good cause: the director formally satisfies the will of one owner but violates the trust of the company as a whole.

In summary, good cause is a flexible yet demanding standard. It requires serious objective assessment from the court (and from the members of the company when they themselves deliberate). In litigation, the burden of proof rests on the party asserting the existence of good cause – the minority member will have to prove the facts that render the removal justified. If successful, the court will take the position that it is in the interest of the company to dismiss the director, even against the will of the majority. In this way, both the minority and the company as a whole are protected from potential abuse by the majority or an unconscionable director.

3.2. Two-Member Companies with equal shares

Two-member companies with equal shares constitute a special category within limited liability companies due to their structural vulnerability to deadlock. In such a company, neither member has a prevailing influence – both have equal decision-making power, which functions smoothly only as long as they are in agreement.⁴⁹ Frequently, both members are also directors of the company, sharing managerial powers. While they agree, equality is an advantage; however, should a conflict arise, the company may fall into a state of complete paralysis, as differences in positions gradually intensify, turn into personal animosity, and the members then cease to consider the interest of the company, focusing instead on obstruction, even when a particular measure would objectively benefit the company.⁵⁰ The consequence is that no decision can be adopted: at the general meeting, each holds 50%, so there is no majority, and in the management board they either block each other or (worse still) both have individual representative authority and issue contradictory declarations of will towards third parties (which creates legal uncertainty for the company's partners). Such a state leads the company into a stalemate – the general meeting can adopt neither a decision on strategic matters, nor on the distribution of profits, capital increase, nor can mutual disputes regarding the conduct of business be resolved. For a dispute, it is already sufficient that the director is not a member of the company at all, but one of the members considers the director biased in favour of the other member and wishes to remove him, while the other member refuses – the result: no decision on removal, and the contested director continues managing the affairs. First, it should be noted that the members of a limited liability company are obliged to cooperate with each other loyally and in the interest of the company. Under healthy circumstances, they are expected to jointly resolve disagreements in the interest of the common venture.⁵¹ However, when the relationship escalates to the point where each pursues only their own interest (or the interest of "their" director), the law must provide solutions.

⁴⁸ Barbić, J., op. cit. in fn. 19, pp. 391, 433.

⁴⁹ Ibid., pp. 437–438.

⁵⁰ Brnabić, R.; Ivkošić, M., Blokada skupštine dvočlanog d.o.o. (1. dio), *Pravo u gospodarstvu*, vol. 54, 1/2015, pp. 15–40, at p. 17.

⁵¹ Brnabić, R.; Ivkošić, M., op. cit. in fn. 50, pp. 30–34.

Croatian law (as well as Austrian law) offers the possibility of excluding a member from the company or their withdrawal as an ultimate measure, but before that, it seeks to resolve the problem at the level of management – by removing the conflicted director. In the described situation, where one director is a puppet of one member, the logical solution is to dismiss that director in order to eliminate the deadlock. However, neither party can independently achieve this, as they lack the majority. Accordingly, each member turns to the court: practice confirms that in severe conflicts within two-member companies, both members frequently initiate lawsuits – one seeks to remove the other from the position of director (if both are directors), and not infrequently they go a step further and seek the exclusion of the other member from the company.⁵² This is the ultimate form of the struggle for dominance: if the court excludes one member, the other assumes 100 percent of the company and the problem is “resolved” through separation, albeit at the cost of a drastic measure. However, court-ordered exclusion of a member is possible only for very serious reasons and with payment of the value of their share, making it a limited remedy. A more efficient and less drastic path is precisely what we have discussed – judicial removal of the director. For two-member companies, Art. 424(3) CA is particularly relevant: if one member blocks removal at the general meeting, the court will, at the request of the other, “break through” that blockade.⁵³ In doing so, the concept of the duty of loyalty is integrated: the members are obliged to vote in favour of removal if good cause exists,⁵⁴ and when they fail to do so, the court may compel them to do so in the interest of the company. The literature emphasises that a deadlock may lead to complete business dysfunction and a threatening inability to pay,⁵⁵ which could even compel the directors to initiate insolvency proceedings. This is all the more reason for the court to proactively apply the mechanisms under Art. 424, rather than awaiting the demise of the company. As a special overview, we once again highlight two legal instruments by which the minority or 50-percent member may operationalise their rights in such a dispute. The minority (or parity) member requests the court, by way of an action, to determine that the other member is obliged to consent to the removal of a particular director. The success of the action depends exclusively on proving good cause. If this is proven, the court, by its decision, substitutes the will of the defendant member, and it is deemed that the decision on removal has been adopted. In practice, this means that the court judgment serves as the basis for the registration of the change of director in the court register (the final judgment is attached instead of the minutes of the general meeting).⁵⁶ The plaintiff is one member against the other member (the company is a possible intervener). This effectively resolves the issue of breach of the member’s duty of loyalty. The High Commercial Court has taken the position that in such proceedings, the court examines and decides exclusively on the existence of good cause, and that if such cause exists, the claim must be granted because the defendant member breached his duty towards the company and towards the plaintiff by not consenting to the removal.⁵⁷ In our case, such an action is essentially the path to the objective – the minority member does not need to sue the company or the director, but directly the “disobedient” majority member who stands behind the director. Psychologically, this also puts pressure on the majority member: instead of hiding behind the formal decision of the general meeting (or the non-adoption of a decision), he personally answers before the court for his conduct.

⁵² Ibid., pp. 34–37.

⁵³ Barbić, J., op. cit. in fn. 19, pp. 436–437.

⁵⁴ Brnabić, R., op. cit. in fn. 2, pp. 443–444.

⁵⁵ Brnabić, R.; Ivkošić, M., *Blokada skupštine dvočlanog d.o.o.* (2. dio), *Pravo u gospodarstvu*, vol. 54, 2/2015, pp. 202–208.

⁵⁶ Barbić, J., op. cit. in fn. 19, p. 445.

⁵⁷ Barbić, J., op. cit. in fn. 19, pp. 437–438.

Often, this alone is sufficient to prompt a settlement – for example, the majority member may offer to purchase the minority member’s share (or vice versa) in order to resolve the dispute, rather than having the court formally “vote” on his behalf. Furthermore, while the court proceedings are ongoing (and they may take months), there is a risk that the contested director will cause irreversible damage. For this reason, there exists the possibility of seeking an interim measure (under the rules on the preservation of evidence or prohibition of action from the Enforcement Act). The minority member must make probable his claim (i.e., the existence of good cause and the risk of delay) and that irreparable harm threatens if the director remains in office. The court may then order a measure appropriate to the situation. In practice, this may be a prohibition against the director from undertaking certain actions – such as entering into new contracts, disposing of assets, or taking out loans – or even a complete prohibition from performing the duties of director until the conclusion of the litigation.⁵⁸ Alternatively, the court may appoint a temporary representative or administrator to assume the management of affairs in place of the contested director. The Austrian GmbHG prescribes a prohibition on the director’s work.⁵⁹ In German judicial practice, in such cases, courts issue interim measures such as the suspension of the director or the appointment of a temporary executor for the protection of the company pending the decision on the merits.⁶⁰ Croatian law does not contain special provisions in the CA on this matter, but these measures may be sought on the basis of the general procedural powers of the courts. The High Commercial Court, for example, upheld a ruling prohibiting one director from undertaking actions beyond the ordinary course of business until the dispute was resolved, as there were indications that his actions could damage the company (a case where two directors were in disagreement and one was attempting to sell off assets) – the court took the position that such a measure was necessary to prevent abuse of managerial powers during the pendency of the dispute (unreported, oral information). In any event, the combination of the action for consent and the interim measure provides the minority member with a potent tool: he may simultaneously initiate proceedings for dismissal and ensure that the contested director “does no further harm” while the proceedings are ongoing. In this way, practically the same effect is achieved as if the director had been immediately removed (since he is prevented from acting), except that the formal resolution comes only through the judgment. In conclusion, in a scenario such as the one we are analysing, the legal system provides multiple levels of protection: from autonomous (articles of association, agreements among members) through corporate (decisions of the general meeting and the duty of loyalty) to judicial (actions and measures). If the director is indeed a puppet who violates the interests of the company, few mechanisms can, in the long run, prevent his removal – whether voluntarily (by the party who appointed him, if he recognises the risks) or compulsorily by court decision. The majority member who supports him must reckon that he too has fiduciary duties and that, due to persistent obstruction of a justified dismissal, he may suffer consequences (from liability for damages to potentially his own exclusion from the company if it is proven that he deliberately acts contrary to the interest of the company). On the other hand, the minority member has the aforementioned remedies at his disposal but must carefully fulfil the conditions – primarily proving good cause. To his advantage, in such a case the evidence (financial losses due to the below-value sale of assets, possibly communications revealing a collusion between the director and the majority member) may relatively objectively substantiate his claims. In this way, with the assistance of the court, he could achieve the objective: the removal of the “external” director who has offended against the interests of the company, despite the opposition of the nominally stronger partner.

⁵⁸ Lenz, J.; Römermann, V., op. cit. in fn. 37, § 8, para. 34.

⁵⁹ Barbić, J., op. cit. in fn. 19, p. 438.

⁶⁰ Lenz, J.; Römermann, V., op. cit. in fn. 37, § 8, para. 34. Cf. Kleindiek, D., op. cit. in fn. 6, § 38, paras. 36–38.

4. ANALYSIS OF JUDICIAL ARGUMENTATION - CASE OF THE HIGH COMMERCIAL COURT

According to the classifications into which under general legal theory legal norms are categorised, these norms are divided into legal institutions, legal branches, and legal areas. The concept that we thematise – the removal of a member of the management board who is not simultaneously a member of the company – constitutes a legal institution. A legal institution is, moreover, the narrowest unit consisting of a smaller number of legal norms.⁶¹ The legal institution – removal of a member of the management board who is not also a member of the company – is studied primarily by the discipline of commercial law and company law, which is a specific legal discipline, but a contribution to the study of the question of removal of a member of the management board is also made by a theoretical discipline – general theory of law. The occasion for a special theoretical-legal analysis within the framework of this paper is a judgment of the High Commercial Court of the Republic of Croatia,⁶² from which it is evident that the second-instance court and the first-instance court hold different positions and argumentation on the question of removal. The court of first instance maintains that in the specific case there is no possibility of removing a member of the management board who is not simultaneously a member of the company, while the second-instance court allows the appeal filed against the ruling of the first-instance court and remands the case for reconsideration.

The first-instance court rejected the proposal of the applicant for interim relief, who had requested that an interim measure be ordered for the purpose of securing a non-monetary claim, which would consist of the removal of the appointment of the member of the management board of the company and that the member of the management board be prohibited from conducting business and representing the company, etc. We cite the argumentation of the first-instance court according to the reasoning of the second-instance court, since this is sufficient for understanding the position of the first-instance court. The second-instance court in its reasoning states that “the first-instance court essentially decides on the basis of the provisions of Art. 424(2) and (3) of the Companies Act, stating that the removal of a member of the management board through the court is possible only in the case where the member of the management board is simultaneously a member of the company (para. 2), and that only in that case may the provision of para. 3 be applied, i.e., that consent be sought from members of the company who did not vote for removal, and then that an interim measure be used to prohibit the member of the management board, whose removal is the subject of the dispute, from conducting business and representing the company, if it is made probable that his further actions would cause irreparable damage to the company” (emphasis added by the authors of this paper). Given that the first-instance court considers that in this case a member of the management board cannot be removed by court decision, it consequently holds that an interim measure cannot be ordered either, and therefore rejects its issuance. In the argumentation, we can identify the use of the method of systematic interpretation, the argument *a contrario*, and the use of the legal standard of “irreparable damage”, which is otherwise interpreted by the method of teleological interpretation.

⁶¹ Such a classification of classificatory units is customary (e.g. Miličić, V., *Opća teorija prava i države*, 8th rev. and suppl. ed., Vlastita naklada, Zagreb 2008, p. 186; Vrban, D., *Država i pravo*, Golden Marketing, Zagreb 2003, p. 383; Visković, N., *Teorija države i prava*, Birotehnik CDO, Zagreb 2006, p. 269; Fábry, B.; Kasinec, R.; Turčan, M., *Teória práva*, Wolters Kluwer, Bratislava 2017, p. 81; Pavčnik, M., *Teorija prava*, 6th ed., Lexpera, GV Založba, Ljubljana 2020, p. 457.

⁶² High Commercial Court of the Republic of Croatia, Case No. Pž-4299/2024-2, available at <https://informator.hr/sudske-odluke/764964?hls=raspolaganju>, accessed 18 January 2026.

By the systematic method we mean the linking of two or more legal provisions in order to derive a new legal provision or a legal norm with a new meaning, arising from that linking.⁶³ We observe the use of the systematic method in the fact that the court expressly – by the conjunction “and” – links the provisions of paragraphs 2 and 3 of Art. 424 CA, stating that paragraph 2 prescribes that the removal of a member of the management board through the court is possible only in the case where the member of the management board is simultaneously a member of the company, and that only in that case may the provision of paragraph 3 be applied, which prescribes that consent be sought from members of the company who did not vote for removal, and that then an interim measure may be used to prohibit the member of the management board, whose removal is the subject of the dispute, from conducting business and representing the company, under the condition that it is made probable that his further actions would cause irreparable damage to the company. Furthermore, we observe here the use of the argument a contrario, which we understand as reasoning whereby from an expressly stated proposition of the court, another proposition not expressly named is derived.⁶⁴ We find the use of this argument when the court stated that the removal of a member of the management board through the court is possible only in the case where the person being removed as a member of the management board is simultaneously a member of the company. From this, the express contrary argument may be derived that in no other case, only (except) when the person being removed is a member of the management board who is also a member of the company, is the removal of the member of the management board possible. And finally, in the argumentation of the court, we find the legal standard – “irreparable damage”. Although the court does not specifically comment on or interpret it, we shall nonetheless state that legal standards are concepts that provide a broad range of possible forms of behaviour that the creators of general norms do not precisely regulate. They leave it to the addressees to give such concepts concrete meanings that best correspond to the particularities of the situations in which they find themselves, and specifically such meanings as a reasonably prudent person would attribute to the concept in a given situation.⁶⁵ They are interpreted by the teleological method, specifically by the method of so-called objective teleological interpretation.⁶⁶ We likewise provide the argumentation of the applicant for interim relief from the reasoning of the second-instance court.

⁶³ Authors agree that in applying this method, all elements are linked (legal norms, legal rules, legal regulations, legal provisions), e.g. Vrban, D., *op. cit. in fn. 61*, p. 472; Visković, N., *op. cit. in fn. 61*, p. 269 et seq.; Miličić, V., *op. cit. in fn. 61*, p. 183; Guastini, R., *Tumačenje i argumentacija*, Naklada Breza, Zagreb 2023, p. 281. We, however, consider that it is most correct to say that legal provisions are linked, since they are the sentences by which legal norms are expressed.

⁶⁴ Visković, N., *op. cit. in fn. 61*, p. 254; Perić, B., *Država i pravni sustav*, 6th ed., Informator, Zagreb 1994, pp. 215–216; Miličić, V., *op. cit. in fn. 61*, pp. 186–187; Harašić, Ž., *Sudska argumentacija*, Pravni fakultet Sveučilišta u Splitu, Split 2010, p. 39.

⁶⁵ Visković, N., *op. cit. in fn. 61*, p. 25. On the legal standard as a type of indeterminate concept, see also Miličić: Miličić, V., *op. cit. in fn. 61*, p. 137. Pavčnik states that the theory of law and the state is a pedagogical subject, see: Pavčnik, M., *op. cit. in fn. 61*, p. 225.

⁶⁶ Visković, N., *op. cit. in fn. 61*, p. 251. While objective teleological interpretation holds that the aim of the legal norm is that which corresponds to the needs of society at the time of interpretation, subjective teleological interpretation holds that the aim of the norm is that which the legislator had in mind at the time of its enactment. Cf. Visković, N., *op. cit. in fn. 61*, p. 250. Thus, we align ourselves with those authors who distinguish between subjective and objective teleological arguments but give preference to the objective teleological argument (Peczenik, A., *On Law and Reason*, Kluwer Academic Publishers, Dordrecht (etc.) 1989, p. 405 et seq.; Vrban, D., *op. cit. in fn. 61*, p. 473; Visković, N., *op. cit. in fn. 61*, p. 259). Although most Croatian authors do not expressly speak of subjective and objective teleological arguments (interpretation), it appears that what they state regarding historical interpretation is equivalent to the subjective teleological argument, while what they state regarding the teleological argument is equivalent to the objective teleological argument (e.g. Vuković, M., *Interpretacija pravnih propisa*, Školska knjiga, Zagreb 1953, p. 97; Perić, B., *op. cit. in fn. 61*, p. 220; Miličić, V., *op. cit. in fn. 61*, p. 181).

Thus, it is stated: “The applicant for interim relief files an appeal against the said ruling on the grounds of a material violation of the provisions of civil procedure, incorrectly and incompletely established facts, and incorrect application of substantive law. He contends that the first-instance court incorrectly applies the provisions of Art. 424(2) and (3) CA, because in the case envisaged by paragraph 3, which should be applied in this case, the issue concerns adversarial proceedings seeking the consent of the other members of the company for the removal of an ‘ordinary’ member of the management board who is not simultaneously a member of the company. For he considers that by accepting the position of the first-instance court, a minority holder of business shares would not be able to influence the removal of a member of the management board in any way, and that such holders would not have at their disposal any legal mechanism for overseeing the work of the management board. In view of the foregoing, he proposes that the contested decision be quashed and the case remanded for new proceedings.” Here too we observe the use of the method of systematic interpretation. Thus, the applicant considers that in this case the provision of Art. 424(3) should be applied, and that the first-instance court incorrectly applied the provisions of Art. 424(2) and (3). We consider that the applicant expressly employed systematic interpretation, as he linked the provisions of paragraphs 2 and 3 by the conjunction “and”. In the argumentation of the second-instance court, it is stated that in the repeated proceedings, the first-instance court must assess the conditions for ordering an interim measure under Art. 424(3) CA, specifically two conditions: first, the conduct of adversarial proceedings within the meaning of that article, initiated by the filing of an action; and second, the existence of probability that the further actions of the member of the management board, whose removal is the subject of the dispute, would cause irreparable damage.⁶⁷ Here too, we are dealing with the application of systematic method of interpretation of the norm.

5. CONCLUSION

The revocation of the appointment of a member of the management board constitutes one of the modes of termination of membership in that corporate body. In a limited liability company, there exists a relationship of subordination of the management board vis-à-vis the general meeting of the company. The general meeting may issue instructions to the management board of that company in the area of business management, which the management board is obliged to observe. In contrast to the management board of a joint-stock company, which conducts the business of that company on its own responsibility and whose members may be removed only for good cause, in a limited liability company, members of the management board (directors) may be removed at any time and without stating any reason whatsoever. This broad power of the general meeting serves as a counterbalance to the very extensive powers of the director to represent the company, and consequently also serves to protect the interests of the company and of its members. The legal standard of good cause for removal has, to a considerable extent, been left by the law to the courts for interpretation. It is for this reason that the need arose for the judicial removal of a member of the management board — a mechanism ensuring legal oversight particularly in situations where, due to the ownership structure, it is not possible to reach a decision on removal within the company despite the existence of good cause. The Companies Act (CA) provides for the judicial removal of a member of the management board who is simultaneously a member of the company (in non-contentious proceedings), upon the request of any other member of the company, provided that good cause is established. Of particular significance is the statutory solution enabling even a minority member of the company to initiate judicial proceedings for the removal of a director who is not a member of the company, against the will of the majority.

⁶⁷ High Commercial Court of the Republic of Croatia, *op. cit.* in fn. 62.

In such a case, the member of the company, by way of an action, requests the other members (who refused to vote in favour of removal) to consent to the removal (Art. 424(3) CA). The director in question is notified of the existence of the dispute, and the court may, in the course of the proceedings, by way of an interim measure, prohibit that director from performing their duties if it is probable that their continued actions would cause irreparable damage to the company. In this manner, the law protects the interests of minority members and of the company as a whole against possible obstruction by the majority supporting the contested director. The justification for such legislative intervention is further confirmed by recent case law — in which the dispute under analysis between a minority and a majority member of the company demonstrated that the contrary interpretation would leave the minority without any effective legal remedy. The analysis also revealed that the method of systematic interpretation of norms is applied. In a comparative context, the solutions under Croatian law are, in their essential aspects, aligned with the modern trends in the protection of the rights of minority members in comparable legislation in Austria and Germany. In any event, it is recommended that decisions on the removal of directors in such situations be adopted unanimously whenever possible.

LITERATURE:

1. Arnold, N.; Pampel, F.-R., in: Gruber, M.; Harrer, F. (eds.), *GmbHG: Kommentar*, 2nd ed., Linde Verlag, Wien 2018.
2. Barbić, J., *Pravo društava*, Book Two: Društva kapitala, Volume 2: Društvo s ograničenom odgovornošću, 8th ed., Organizator, Zagreb 2025.
3. Beurskens, M., in: Noack, U.; Servatius, W.; Haas, U. (eds.), *GmbH-Gesetz*, 24th ed., C.H. Beck, München 2025.
4. Brnabić, R., Opoziv člana uprave društva s ograničenom odgovornošću, *Pravo u gospodarstvu*, vol. 56, 3/2017, pp. 431–450.
5. Brnabić, R.; Ivkošić, M., Blokada skupštine dvočlanog d.o.o. (1. dio), *Pravo u gospodarstvu*, vol. 54, 1/2015, pp. 15–40.
6. Brnabić, R.; Ivkošić, M., Blokada skupštine dvočlanog d.o.o. (2. dio), *Pravo u gospodarstvu*, vol. 54, 2/2015, pp. 195–220.
7. Fábry, B.; Kasinec, R.; Turčan, M., *Teória práva*, Wolters Kluwer, Bratislava 2017.
8. Gorenc, V.; Česić, Z.; Buljan, V.; Brkanić, V., *Komentar Zakona o trgovačkim društvima*, RRiF-plus, Zagreb 2008.
9. Guastini, R., *Tumačenje i argumentacija*, Naklada Breza, Zagreb 2023.
10. Harašić, Ž., *Sudska argumentacija*, Pravni fakultet Sveučilišta u Splitu, Split 2010.
11. Heilmeyer, M., in: Ziemons, H.; Jaeger, C.; Pöschke, M. (eds.), *BeckOK GmbHG*, 66th ed., C.H. Beck, München 2024.
12. Kleindiek, D., in: Bayer, W.; Hommelhoff, P.; Kleindiek, D. (eds.), *GmbH-Gesetz: Kommentar*, 21st ed., Verlag Dr. Otto Schmidt, Köln 2023.
13. Kollmorgen, A.; Ruf, T., in: Happ, W.; Groß, W. (eds.), *Aktienrecht: Handbuch – Mustertexte – Kommentar*, vol. IV: GmbH, 5th ed., Carl Heymanns Verlag, Köln 2020.
14. Lenz, J.; Römermann, V. (eds.), *Münchener Anwaltshandbuch GmbH-Recht*, 5th ed., C.H. Beck, München 2023.
15. Miličić, V., *Opća teorija prava i države*, 8th rev. and suppl. ed., Vlastita naklada, Zagreb 2008.
16. Oetker, H., in: Henssler, M.; Strohn, L. (eds.), *Gesellschaftsrecht*, 6th ed., C.H. Beck, München 2024.
17. Pavčnik, M., *Teorija prava*, 6th ed., Lexpera, GV Založba, Ljubljana 2020.
18. Peczenik, A., *On Law and Reason*, Kluwer Academic Publishers, Dordrecht 1989.
19. Perić, B., *Država i pravni sustav*, 6th ed., Informator, Zagreb 1994.

20. Rowedder, H.; Schmidt-Leithoff, C. (eds.), *Gesetz betreffend die Gesellschaften mit beschränkter Haftung (GmbHG): Kommentar*, 6th ed., Vahlen, München 2017.
21. Schneider, U. H.; Schneider, S. H., in: Scholz, F. (founder), *Kommentar zum GmbH-Gesetz*, vol. II, 12th ed., Verlag Dr. Otto Schmidt, Köln 2021.
22. Stephan, K.; Tieves, J., in: Fleischer, H.; Goette, W. (eds.), *Münchener Kommentar zum Gesetz betreffend die Gesellschaften mit beschränkter Haftung (GmbHG)*, vol. II, 4th ed., C.H. Beck, München 2023.
23. Terlau, M., in: Michalski, L.; Heidinger, A.; Leible, S.; Schmidt, J. (eds.), *Kommentar zum Gesetz betreffend die Gesellschaften mit beschränkter Haftung (GmbH-Gesetz)*, vol. II, 3rd ed., C.H. Beck, München 2017.
24. Visković, N., *Teorija države i prava*, Birotehnika CDO, Zagreb 2006.
25. Vrban, D., *Država i pravo*, Golden Marketing, Zagreb 2003.
26. Vuković, M., *Interpretacija pravnih propisa*, Školska knjiga, Zagreb 1953.

USE OF AI METHODS IN STATISTICAL ANALYSIS, WITH SPECIAL FOCUS ON SERVICES

Iris Mihajlovic

*University of Dubrovnik, Croatia
iris.mihajlovic@unidu.hr*

Dorotea Markasovic

*University of Dubrovnik, Croatia
dorotea.markasovic@unidu.hr*

Lukrecia Draskovic

*University of Dubrovnik, Croatia
lukreciadraskovic@gmail.com*

ABSTRACT

The use of artificial intelligence (AI) methods in statistical analysis has been rapidly increasing, reshaping contemporary research practices. Two prominent AI approaches applied in statistics are discriminative and generative AI, with discriminative AI playing a key role in machine learning (ML), computer vision, and natural language processing. Focusing on ML, AI techniques are commonly implemented through supervised, unsupervised, and reinforcement learning. These approaches are closely connected to traditional statistical dependence and interdependence methods. Supervised learning relies on labeled data and includes methods such as linear and logistic regression, decision trees, neural networks, and support vector machines, while unsupervised learning focuses on pattern discovery using tools like clustering and principal component analysis (PCA). In the context of services, AI-supported statistical analysis has particular relevance due to the intangible, heterogeneous, and data-intensive nature of service processes. Service sectors such as hospitality, tourism, healthcare, and finance increasingly apply AI to analyze customer behavior, service quality, satisfaction, and demand patterns. Scientific contribution of this paper primarily refers to the critical approach and review of effective use of secondary digital technologies that constitute a critical methodological asset in service-sector research, enhancing the accuracy, consistency, and comparability of large-scale datasets. By reducing measurement error and facilitating rigorous statistical analyses, they strengthen the validity of empirical findings and provide a robust foundation for evidence-based interpretation. Techniques like clustering and PCA enable segmentation of service users, while predictive ML models support personalized services and operational optimization. A comparison between ML and statistical modeling highlights differences in purpose, data requirements, and interpretability. While ML prioritizes prediction, statistical methods emphasize inference. Despite AI's benefits, issues such as data reliability and the distinction between correlation and causation remain critical, underscoring the continuing role of human expertise in service-related research and decision-making.

Keywords: *Artificial Intelligence (AI), Interpretability, Marketing efficiency, Service Systems, Time convergence*

1. INTRODUCTION

The application of secondary digital technologies in the service sector has been extensively examined by a number of influential scholars who emphasize their role in improving data transparency, analytical clarity, and decision-making accuracy. In tourism and related service industries, authors such as Buhalis and Law (2008) and Gretzel et al. (2015) highlight how digital platforms enable spatial – temporal convergence by integrating real-time data across locations and time zones, thereby enhancing service coordination and consumer accessibility.

Marketing scholars, including Kotler, Kartajaya, and Setiawan (2017), stress that digitalization increases market transparency through more accurate price signaling, improved information symmetry, and easier comparison of service offerings, which ultimately benefits both consumers and providers. Furthermore, Davenport and Harris (2007) and McAfee and Brynjolfsson (2012) underline that secondary digital data – such as platform analytics, online reviews, and transaction records – allow for more precise statistical analysis, time savings, and higher data reliability. These technologies support clearer interpretation of results by reducing informational noise and enabling structured, data-driven insights. Collectively, this body of literature demonstrates that the integration of digital technologies in the service sector is not merely an operational enhancement, but a foundational mechanism for achieving statistical transparency, interpretative accuracy, and evidence-based strategic planning. Therefore, research questions are following:

RQ1: How AI methods may be used in statistical analysis in tourism?

RQ2: How reliable is the application of secondary digital technologies in statistical analysis in service research?

Some authors cite a high level of dependence of market segment characteristics, with regard to age, geographic aspect, education, level of education of tourists, and considering the use of primary digital technologies in key activities of travel (booking) (Dumičić et al., 2016).

2. CONCEPTUAL FRAMEWORK

The more a man invests in innovation, the better, because as a result, the country, and even the continent, progresses (Kacprzyk, 2022). Decision making in every industry is in a time of great change. Carlsson (2018) underlined that knowledge management becomes knowledge mobilization, and that strong analytics capability is key to digital business. But, also, according to the Ashenfelter (2008) and his research on predicting the quality and prices of Bordeaux wine, professional knowledge is a necessity in the ‘‘digital revolution’’. In his research he showed that complexity, despite it may work in specific cases, will reduce validity in most cases (Ashenfelter, 2008). So, despite AI methods can help in conducting analysis, professional knowledge still remains irreplaceable. This is applicable in many different industries and sectors. Carlsson (2018) also offered some insights into the digital fusion, important for decision making. For example, he introduced an intersection of big data, and fast data. Algorithms used to the determine what is important in information fusion can help experts in decision making. The final result is knowledge fusion (ontology), i.e., it should be integrated complete knowledge about the topic that will help in decision making. But then the question is, is this large amount of data always very useful? It turns out that it is not. As Carlsson (2018) showed in an example where company wanted to replace experienced engineers with youngsters operating automated systems. There were three main, and important observations: a) large parts of the knowledge is tacit (very hard or even impossible to capture with formal tools); b) with more precision in the description, there was a decrease in relevance (overall picture was lost); c) inexperienced operators couldn’t master the complexity. As Zadeh stated: *‘‘you can increase precision if you are willing to give up on relevance or you can increase relevance if you are willing to give up on precision, but you cannot do both at the same time’’*. These three observations are very important when it comes to decision making in economics because it influences human resource management, budgeting for modernization of business processes, and so on. As previously underlined, if the manager is good in optimization, and probably use some multi-objective optimization model, that is still model. Changing parameters in the model may result in entirely different suggestions by AI, so people are still irreplaceable.

There is also a question of how many events are covered in the model, and this depends on someone who is creating the model. This can be observed in more detail in countries in transition (like CEE countries): while they still have older experts on the managerial positions, or people who are not fairly educated in this area, there is no “bridge” for knowledge transfer – such directors tend to hire young people with skills of modelling, with high expectations that the models will work efficiently, while they do not put enough time in transferring their (practical, tacit) knowledge to the younger generations. This can be one of interesting reasons to observe in the area of digital transformation of business. Kacprzyk (2025) also highlighted that a human is a key player for decision making, despite AI is crucial, especially in the contemporary surroundings. Kacprzyk (2025) said that human shouldn't be replaced, but “aided” with technology. So, finding a better way to mobilize tacit knowledge from those experts is a challenge for many businesses. Carlsson (2018) ultimately highlighted a central challenge in knowledge management: ensuring that the information and insights being applied are accurate, contextually relevant, and valid for the specific situation in which they are used. Perhaps the zero step should be to determine who are the experts need for these, and what is the criteria for choosing one, and after this, it can be proceeded according to the other following steps. Another possible application of decision making in economics is given by Carlsson (2018) in the example of optimizing the portfolio. Merton (1973) became famous because he introduced real options as a good description for building portfolio in financial markets. The real option rule says that one should invest today only if the net present value (NPV) is high enough to compensate for giving up the value of the option to wait. The point was to have the possibility, but not to be committed. More plastic explanation is that investor wanted to buy a house, but someone else was quicker, and it is sold (“the fast eat the slow”). Now investor still has money, and waits for some other opportunity. In this case, so called “loss” (because the investor still didn't make purchase), becomes an opportunity for some other investment. The main question here is how long the investment should be postponed, how many T time periods? Now it becomes increasingly hard to decide as there is uncertainty about the outcome of the investment. Real options are also used when it comes to managerial decision (for example, classical methods in project management are net present value, and discounted cash flow), or patenting process. Such problems can be solved by sums of rows, for example (one of the classical real option models). Other fuzzy real options can be a little bit challenging to understand. So, maybe the best option is optimal real options portfolio – numerical method of finding the expected value and a probability distribution of a project (because everything today may be called project). In this case, key uncertainty parameters are given as input distributions, and then the results can be analyzed statistically, which is a good way to valuate real options. “With real option valuations management will get guidance for their decisions to invest, or to postpone investments, and if so to postpone them T time periods. There may be challenges to see what is a “current real option” or to verify that it is correct” (Carlsson, 2018). Decision support systems, digital ecosystems, AI and digitalization can make this process easier, we only need to know how, and what tools to use.

3. METHODOLOGY

In order to achieve the above-mentioned research goal, a structured and methodologically grounded approach was applied through the use of several complementary scientific methods. The conceptual framework is modeled using a systematic approach of systematic literature review, that served as the foundational method, enabling the identification, evaluation, and synthesis of relevant theoretical and empirical contributions within the existing body of knowledge. The comparison method was employed to examine similarities and differences across prior studies, models, and empirical findings, thereby facilitating a critical assessment of diverse perspectives and analytical approaches.

Furthermore, the compilation method was used to integrate insights from multiple scientific sources, including academic journals, books, and reputable online databases, into a coherent analytical framework. The classification method supported the organization of concepts, indicators, and variables into logically structured categories, which enhanced conceptual clarity and analytical consistency. The description method was applied to systematically explain observed phenomena, processes, and relationships relevant to the research topic, providing a clear contextual understanding.

Finally, the methods of analysis and synthesis were jointly employed to deconstruct complex theoretical constructs into their key components and subsequently recombine them into an integrated interpretative model (Zelenika, 1998). The research results are based exclusively on secondary data, obtained from a wide range of scientific publications and authoritative databases, ensuring methodological reliability, analytical transparency, and the validity of the research conclusions. Critical views of authors dealing with this issue were analyzed, with special emphasis on the application of secondary digital technology through the technique of reading information related to the quality of communication, the transparency of measurable indicators (for example, price, cost aspect, time savings).

4. RESULTS

In this section, the results are divided into two subsections. Firstly, the application and advantages of AI methods in statistical analysis in tourism has been considered. In the second part, the reliability of the application of secondary digital technologies in statistical analysis in service research has been emphasized.

4.1. Application and advantages of AI methods in statistical analysis in tourism

Use of AI methods in statistical analysis nowadays has an increasing application. Some of noticeable AI methods used in a statistical analysis are a) discriminative AI, and b) generative AI. Discriminative AI helps in machine learning, computer vision, and natural language processing. Considering machine learning only, AI is involved in the following processes: supervised learning, unsupervised learning, reinforcement processing. The link with statistical methods can be seen through dependence and interdependence methods used in supervised learning, and unsupervised learning (Woloszyn & Bukowski, 2025). Supervised learning includes different tools and methods, like decision trees, linear regression, logistic regression, neural networks, support vector machines (SVM), and so on; while unsupervised learning includes clustering, principal component analysis (PCA), and so on. On the other hand, dependent statistical methods necessarily have one (or more) dependent variable(s), and one (or more) independent variable(s).

Dependent variables are either quantitative or qualitative, while independent variables can be both at the same time. Here, the goal is to determine absence or presence of relationship between examined variables. Interdependence statistical methods include both qualitative and quantitative types of data and two (or more) variables. The main goal is to identify how and why the variables are related among themselves. Comparing machine learning (ML; as part of AI) and statistical methods, there are three main elements by which they differ: purpose, data, and interpretability (**table 1**).

Table 1. ML vs statistics (modelling approach)

Modelling approach	Purpose	Data	Interpretability
ML	to find patterns in data and leverage these patterns to make accurate predictions	Large datasets	Lack of interpretability vs high predictive accuracy
Statistics	to make inferences about a population and understand the relationship between variables based on a sample of data	Smaller datasets	Focus on interpretability to establish the significance of relationship

Source: Woloszyn & Bukowski, 2025

It is already mentioned that under machine learning (ML) it can be found supervised learning, unsupervised learning, and reinforcement learning. In supervised learning there are used labeled data, and it is opposite in unsupervised learning, which is used for learning patterns. In supervised learning the goal is to learn a function. In reinforcement learning agent gets feedback in the form of positive (award) or negative (punishment) numerical value, after each action. ML can be helpful in statistical analysis. Econometric and AI model is differing according to the 3 main parameters: linear assumptions, statis models, causality vs correlation. In econometric model, the assumption is that the relationship is linear, that there is causality, and that the model is valid for the all times. On the other hand, in AI models' main assumptions are that a model autonomously adapts while it is in the use, that there is correlation, and that there is non-linearity (Woloszyn & Bukowski, 2025).

AI methods are already used in statistical analysis. In particular, chat GPT can summarize data from different sources, even write a custom-made formula (for a data that scientist has, not the general formula). Such use of AI can be aligned with the need of statistical interpretation, and not too complicated, but help optimize research process. Arhipova (2025) gave an example of PCA vs cluster analysis in human resource management. In cluster analysis, there were 4 clusters in the end (outstanding applicant, mathematician, self-confidence, high social competence), while PCA gave a division by columns, joining those that were similar according to what they were asking about (in this case, for example, test3 and test4 switched the places). PCA, firstly conducted, made easier to run cluster analysis, making these results more obvious.

As illustrated, AI can be very useful for statistical analysis, but there are still come challenges that has to be sold (like, reliability of the data used for analysis, etc.). Despite there is tight connection between AI methods and statistical analysis, correlation (e.g., determined by AI) does not imply causation. For example, if there is a correlation between number of sold cakes, and rainfall increase (precipitation), scientist should decide whether this is important for the research or not (does this indicate that people are depressed, is this a good time for cake manufacturers to raise prices, has anyone already come to a similar conclusion, are we talking here only about, for example, the phenomenon of the autumn period, is it the same in Guatemala during that period, or is it only regionally valid, is it worth connecting these variables at all or not...?).

In general, AI tools are useful and will be so, but humans (scientists) will have to remain the "managers" in this process, be the decision makers and evaluators, the interpreters. That's why it's important to know theoretical foundations, to develop critical thinking and connect it all in the research process. In the end, Arhipova (2025), according to the James et al. (2021) proposed two recommendations about when to use AI, or statistical approach: a) when the goal is inference, simple and relatively inflexible statistical learning methods provide clear advantages; b) if the focus is on prediction and interpretability is not a concern, using the most flexible AI model available is the best approach. In any case, there is a strong bond between AI and statistical methods.

4.2. Reliability of the application of secondary digital technologies in statistical analysis in service research

To understand reliability theory, it is first necessary to clarify the concept of reliability, which may vary depending on the application context, such as in the design of load-bearing structures. In general, reliability is defined as the ability of an item to perform its intended function under specified operating and environmental conditions for a defined period of time (ISO 1996: 8402). According to Smith (1981), reliability is an inherent property of an item, commonly denoted by R , and expressed as the probability that the item will perform its required function within a given time interval under specified conditions.

From a quality perspective, reliability may also be understood as the ability of an item to remain functional throughout its operational life (Jardine & Tsang, 2022). Reliability does not imply the complete absence of failures, as individual components – particularly redundant ones – may fail and subsequently be repaired without compromising overall system performance. Consequently, the concept of reliability applies equally to both non-repairable and repairable items (Birolini, 1997). For reliability measures to be meaningful, numerical values (e.g., $R = 0.9$) must be accompanied by clear information regarding the function of the item, the specified operating time interval, and the relevant operational conditions (Jin, 2019). Reliability assessment can be approached in two ways.

Predicted reliability is obtained through analytical modeling based on component reliability and system structure, whereas actual reliability is derived from reliability testing and field data under known operational and environmental conditions (Jardine & Tsang, 2022). Ultimately, reliability theory encompasses a set of concepts, mathematical models, and methods aimed at predicting, evaluating, understanding, and optimizing the lifetime and performance of systems and their components (Jin, 2019). Reliability is commonly expressed as a time-dependent function, $R(t)$, representing the probability that no failure occurs within the interval $(0, t]$, assuming the item is new at the beginning of operation ($R(0) = 1$) (Jardine & Tsang, 2022).

Ultimately, reliability theory is defined as (Jin, 2019): a set of ideas, mathematical models, and methods aimed at predicting, assessing, understanding, and optimizing the lifetime of systems and their components. Often, the duration of operation T is taken as the parameter t ; then the reliability function is defined in terms of t , i.e. as $R(t)$. $R(t)$ represents the probability that a failure of an object will not occur on the interval $(0, t]$, generally assuming that $R(0) = 1$, i.e., that the object is new at the beginning of the interval (Jardine & Tsang, 2022).

The probability that a component E_i will function at some point in time, i.e., its reliability, is calculated according to expression (1) from the source (Dhillon, 2007):

$$R_i(t) = e^{-\int_0^t [\lambda_i(t) + \mu_i(t)] dt} \left[1 + \int_0^t \mu(t) e^{\int_0^t [\lambda_i(t) + \mu_i(t)] dt} dt \right] \quad (1)$$

The calculation is simpler when the values of work intensity λ_i and repair intensity μ_i are expressed as constants (Dhillon, 2007):

$$\lambda_i = \frac{1}{tf_i} \quad (2)$$

where tf_i is the expected time to failure, or uptime, and in the formula (Dhillon, 2007):

$$\mu_i = \frac{1}{tr_i} \quad (3)$$

The expected time required for correction is written as tr_i .

If the previous assumptions are taken into account, the reliability of the E_i component can be calculated as (Dhillon, 2007):

$$R_i(t) = \frac{\mu_i}{\lambda_i + \mu_i} + \frac{\lambda_i}{\lambda_i + \mu_i} \cdot e^{-(\lambda_i + \mu_i)t} \quad (4)$$

If t is sufficiently large compared to the failure times tf_i , i.e. when it tends to infinity ($t \rightarrow \infty$), then the reliability can be written as (Dhillon, 2007):

$$R_i = \frac{\mu_i}{\lambda_i + \mu_i} \quad (5)$$

In a similar manner, secondary digital technologies demonstrate high reliability in the collection, processing, and integration of large volumes of data. Their automated and standardized procedures ensure consistent reproduction of information across diverse sources, significantly reducing measurement error and supporting accurate statistical analysis. Just as reliability theory quantifies the probability that a component will perform its intended function under specified conditions over a given time interval, the reliability of secondary digital technologies can be understood as their consistent ability to deliver precise and usable datasets for research purposes. Consequently, applying reliability concepts to digital data systems highlights their methodological importance, ensuring that predictions, analyses, mostly throughout marketing transparency, efficiency of time usage, availability of the information, shorter communication path, time-space convergence, as stated by the Buhalis & Law (2008). This is the fundamental for further data interpretation of results. Therefore, interpretations based on these data are both robust and trustworthy. That indicators are fundamental core base for further research where time is one of the most valuable variables, and where space is defined with convergences and divergent conditions of supply and demand.

Secondary digital technologies do not substitute statistical models; rather, they complement them by extending analytical scope and enhancing the examination of key variables relevant to the dynamics of mobility and structural change in tourism systems. This complementarity is particularly evident in advanced predictive approaches – such as neural networks and random forest models – which are increasingly favored for trend forecasting over traditional linear methods (Buhalis et al., 2019). By enabling the processing of large-scale datasets derived from mobile data sensors, big data infrastructures, and financial transaction flows, artificial intelligence (AI), as a secondary digital technology, provides a critical input for improving the precision, transparency, and interpretability of statistical analyses. Automated information extraction, data cleaning, and anomaly detection through normalization further facilitate segmentation and classification, resulting in more homogeneous datasets suitable for economic and business research. In the tourism context, AI enhances the analytical clarity required for advanced modeling, particularly as a preparatory stage for tourism demand forecasting. Tourism demand is inherently heterogeneous, fragmented, and dynamic, and is further shaped by seasonality and inconsistent consumer behavior (Gretzel, 2018). AI-based models support the analysis of user-generated content and traveler preferences through primary digital technologies such as social media platforms. These analytical processes generate evidence-based decision-making frameworks grounded in systematic data evaluation, informing insights into travel motivations, behavioral patterns, temporal consumption fluctuations, and differentiated responses across demographic segments. Beyond conventional quantitative indicators that measure arrivals and capacity utilization, a systematic forecasting approach must integrate historical time-series dynamics with forward-looking qualitative assessments (Laaroussi et al., 2023). Innovation-driven predictive models are therefore required to demonstrate both structural coherence and predictive validity by projecting outcomes into future time horizons within a defined reliability framework. This necessitates adaptive, tailored (*ad hoc*) modeling strategies that align temporal dynamics with variable consistency, thereby strengthening the robustness and applicability of tourism analytics.

5. DISCUSSION & CONCLUSIONS

Secondary digital technologies play a pivotal role in contemporary service-sector research by enabling the systematic collection, processing, and interpretation of large volumes of secondary data. Conceptually, these technologies encompass digital platforms, analytics tools, online databases, and information systems that aggregate data generated through tourism activities, digital marketing channels, pricing platforms, and service interactions. Their primary significance lies in facilitating spatial-temporal convergence, whereby information from different locations and time periods is integrated into coherent datasets, allowing for more comprehensive and comparable statistical analyses. From an analytical perspective, the application of secondary digital technologies enhances marketing and price transparency by reducing information asymmetry and improving the consistency and comparability of observed variables. This contributes directly to greater accuracy, accessibility, and timeliness of data, which in turn reduces measurement error and supports more reliable statistical inference. Moreover, the automation and standardization of data processing result in significant time savings and enable researchers to focus on interpretation rather than data preparation. Consequently, secondary digital technologies represent a critical methodological foundation for achieving statistical clarity, as they improve the readability of data, strengthen the validity of empirical results, and provide a robust basis for evidence-based interpretation in service-sector research. A complete theoretical framework of the study would integrate the role of artificial intelligence with information efficiency, marketing transparency, data accuracy, and convergence as inputs to statistical analysis for interpreting results in tourism research.

Each of these variables has been examined theoretically in prior scholarship: information efficiency in real-time data analysis (Chen et al., 2025; Buhalis & Amaranggana, 2015), marketing transparency through algorithmic strategies that shape transparent market communication (Wilson-Barnao, 2017), data accuracy and cleanliness in research involving large datasets (Kitchin, 2014), and data convergence in smart tourism ecosystems where multiple data sources are synthesized for comprehensive insights (Buhalis & Amaranggana, 2015). Additionally, scenario simulations in tourism support deeper understanding of tourist behavior, seasonality, and market trends when informed by big data and AI-based predictive models (Xiang et al., 2017, Xiang et al., 2009). Collectively, these constructs provide a cohesive theoretical basis for employing AI and advanced analytics as complementary tools alongside statistical models in tourism research. The integration of secondary digital technologies, particularly AI-driven analytical frameworks, has important implications for both academic research and practical decision-making in tourism. By complementing traditional statistical models, these technologies enable a more nuanced understanding of complex, nonlinear relationships inherent in tourism systems, thereby improving the reliability and responsiveness of predictive insights (Neuhofer et al., 2015, Gretzel et al., 2015, Xiang et al., 2017, Xiang et al., 2009). From a managerial and policy perspective, AI-supported analytics facilitate evidence-based planning, more accurate demand forecasting, and adaptive strategy formulation in environments characterized by uncertainty and volatility. In conclusion, the convergence of advanced statistical modeling and secondary digital technologies represents a critical methodological advancement in tourism research, strengthening analytical robustness while expanding interpretative capacity. Future research should further explore hybrid modeling approaches that integrate explainability, reliability assessment, and ethical considerations to ensure sustainable and transparent applications of AI in tourism analytics.

LITERATURE:

1. Ashenfelter, O. (2008). Predicting the Quality and Prices of Bordeaux Wine. *The Economic Journal*, 118(529), F174–F184.
2. Birolini, A. (1997). *Quality and Reliability of Technical Systems Theory, Practice, Management*. 2nd ed. Springer-Verlag, Berlin
3. Buhalis D, Harwood T, Bogicevic V, Viglia G, Beldona S, Hofacker C (2019), Technological disruptions in services: lessons from tourism and hospitality. *Journal of Service Management*, Vol. 30 No. 4 pp. 484–506.
4. Buhalis, D., & Amaranggana, A. (2015). Smart tourism destinations: Enhancing tourism experience through personalisation of services. In I. Tussyadiah & A. Inversini (Eds.), *Information and communication technologies in tourism* pp. 377–389. Springer. https://doi.org/10.1007/978-3-319-14343-9_28
5. Buhalis, D., & Law, R. (2008). Progress in information technology and tourism management: 20 years on and 10 years after the Internet – The state of eTourism research. *Tourism Management*, 29(4), 609–623. <https://doi.org/10.1016/j.tourman.2008.01.005>
6. Carlsson, C. (2018). Decision analytics mobilized with digital coaching. *Intelligent Systems in Accounting, Finance & Management*, 25(1), 3-17. <https://doi.org/10.1002/isaf.1421>
7. Chen, J., Lu, L., Chen, M., Qu, T., & Li, Z. (2025). Optimization of artificial intelligence algorithms for intelligent manufacturing: Enhancing production efficiency and supply chain stability. *Journal of Organizational and End User Computing*, 37(1), 1-28. <https://doi.org/10.4018/JOEUC.392071>
8. Davenport, T. H., & Harris, J. G. (2007). *Competing on analytics: The new science of winning*. Harvard Business School Press.
9. Dhillon, B. S. (2007). *Applied reliability and quality: Fundamentals, methods and procedures*. Springer.

10. Dumičić, K., Žmuk, B. i Mihajlović, I. (2016). Panel Analysis of Internet Booking of Travel and Holiday Accommodation Indicators. *Interdisciplinary Description of Complex Systems*, 14 (1), 23-38. <https://doi.org/10.7906/indecs.14.1.3>
11. Gretzel, U. (2018). From smart destinations to smart tourism regions, *Investigaciones regionales. Journal of regional research*, Asociación Española de Ciencia Regional, issue 42, pages 171-184.
12. Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: Foundations and developments. *Electronic Markets*, 25(3), 179–188. <https://doi.org/10.1007/s12525-015-0196-8>
13. International Organization for Standardization. (1996). *ISO 8402: Quality management and quality assurance – Vocabulary*. ISO.
14. James, G., Witten, D., Hastie, T., Tibshirani, R. (2021). *An Introduction to Statistical Learning with Applications in R*. 2nd edition, Springer.
15. Jardine, A. K. S., & Tsang, A. H. C. (2022). *Maintenance, replacement, and reliability: Theory and applications* (2nd ed.). Routledge.
16. Jin, T. (2019). *Reliability engineering and services*. Springer.
17. Kacprzyk, J. (2022). *AI-enabled decision aid and decision support for symbiotic autonomous systems*. Paper presented at the 4-5. <https://doi.org/10.1109/ICCICC57084.2022.10101649>
18. Kitchin, R. (2014). *The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences*. SAGE.
19. Kotler, P., Kartajaya, H., & Setiawan, I. (2017). *Marketing 4.0: Moving from traditional to digital*. Wiley.
20. Laaroussi, H., Guerouate, F., & Sbihi, M. (2023). Deep learning approach and topic modelling for forecasting tourist arrivals. *International Journal of Electrical and Computer Engineering Systems*, 14(4), 411–419. <https://doi.org/10.32985/ijeces.14.4.5>
21. McAfee, A., & Brynjolfsson, E. (2012). Big data: The management revolution. *Harvard Business Review*, 90(10), 60–68.
22. Merton, R. C. (1973). An Intertemporal Capital Asset Pricing Model. *Econometrica*, 41(5), 867–887.
23. Neuhofer, B., Buhalis, D., & Ladkin, A. (2015). Smart technologies for personalized experiences. *Journal of hospitality and tourism technology*, 6(3), 228-244.
24. Smith, D. J. (1981). *Reliability and maintainability in perspective: Technical, management and commercial aspects*. John Wiley & Sons.
25. Wilson-Barnao, C. (2017). How algorithmic cultural recommendation influence the marketing of cultural collections. *Consumption, Markets and Culture*, 20(6), 559-574. <https://doi.org/10.1080/10253866.2017.1331910>
26. Woloszyn, J., & Bukowski, S. (2025). The impact of AI on economic modelling. *European Research Studies*, XXVIII(Issue 1), 640-660. <https://doi.org/10.35808/ersj/3927>
27. Xiang, Z., Du, Q., Ma, Y., & Fan, W. (2017). A comparative analysis of major online review platforms. *Tourism Management*, 58, 51-65.
28. Xiang, Z., Gretzel, U., & Fesenmaier, D.R. (2009). Semantic Representation of Tourism on the Internet. *Annals of tourism research*, 36(4), 627-645.
29. Zadeh, L.A. (1965). Fuzzy sets. *Information and Control*, 8(3), 338-353.
30. Zelenika, R. (1998). *Metodologija i tehnologija izrade znanstvenog i stručnog djela*. Ekonomski fakultet u Rijeci, Rijeka

THE MEDITERRANEAN YACHT CHARTER MARKET IN A CONTEMPORARY CONTEXT: A QUANTITATIVE ANALYSIS OF SUPPLY, PRICES, AND FLEET UTILIZATION

Daniela Gracan

*Faculty of Tourism and Hospitality Management, University of Rijeka, Croatia
danielag@fthm.hr*

Marina Barkidija Sotosek

*Faculty of Tourism and Hospitality Management, University of Rijeka, Croatia
marinab@fthm.hr*

Ani Trstenjak

*Star d.o.o. Yacht Rent, Kostrena, Croatia
ani.trstenjak@yacht-rent.com*

ABSTRACT

Nautical charter has become an indispensable and increasingly significant segment of supply and demand in nautical tourism. This paper defines charter activity and presents a quantitative analysis of supply, prices, and fleet utilisation in the Mediterranean yacht charter market for the year 2026. The purpose of the paper is to show trends in the boat rental market, which has the highest annual growth rate in nautical tourism. Based on the results of this research, appropriate conclusions and positions have been adopted, incorporating certain views on improving the quality of this nautical tourism product and charter offer. The study demonstrates a replicable approach for combining vessel-level pricing with capacity data to calculate per-person costs, providing a useful framework for future research in nautical tourism economics.

Keywords: *Nautical Tourism, Yacht Charter, Mediterranean, Quantitative Analysis*

1. INTRODUCTION

Nautical tourism represents a distinct segment of marine tourism, encompassing a range of leisure-oriented activities, including cruising, private maritime tourism, yachting, and coastal recreational navigation (Diakomihalis, 2007; Russo & Rindone, 2022). Luković (2007) defines nautical tourism as the entirety of multifunctional activities and relations caused by the stay of tourists-boaters in nautical tourism ports or out of them and by the use of vessels and other objects related to nautical tourism aimed at recreation, sports, and entertainment, and other needs. According to Luković (2008), as a form of tourism, nautical tourism represents a complex tourism–maritime concept. Owing to its strong and direct connection with the sea and navigation, its definition is inherently complex. The maritime component alone does not fully determine nautical tourism, although such a conclusion might be drawn from a superficial analysis. A comprehensive definition of nautical tourism, therefore, requires consideration of all elements that condition and define it. According to Luković (2008), nautical tourism can be divided into the following categories:

1. nautical tourism ports and marinas,
2. charter activities, and
3. cruising.

This typology is commonly applied in developed European countries and is aligned with the prevailing macro-strategic development model as well as with the natural factors influencing tourism development.

From a European perspective, research on nautical tourism commonly focuses on five principal geographical markets: the Mediterranean region, the European Atlantic coastline, the Baltic Sea and Arctic areas, European lakes and inland waterways, and the Black Sea region (Luković, 2012; Russo & Rindone, 2022). The existing tourism literature reveals a wide knowledge and empirical evidence concerning nautical tourism that predominantly focuses on its environmental or social impacts. When narrowing the scope to yacht charter tourism as a specific segment of nautical tourism, references to this activity within international scientific tourism research appear to be largely absent (Alcover et al., 2011). This study seeks to address this gap by examining the economic significance of yacht charter tourism. Consequently, nautical tourism and yacht charter tourism in particular can be considered a high-value-added tourism product that warrants greater attention in the formulation of tourism development and promotion policies for marine tourism destinations.

2. CHARTER TOURISM IN THE CONTEXT OF NAUTICAL TOURISM DEVELOPMENT

The term "charter" was first mentioned in the 1930s in the Netherlands, before spreading throughout Europe and later to America. Charter, as an economic activity and particularly as a segment of nautical tourism, is relatively recent and first appeared on the Côte d'Azur in 1955. Charter refers to the business of renting vessels or ships (Luković & Gržetić, 2007). There are different types of charter (Čarter.hr):

- Bareboat charter: persons who rent a vessel operate it independently, provided they have a valid licence and proven experience. In this type of charter, the person who rents the vessel is solely responsible for the sailing plan, crew safety, and all technical aspects during the charter.
- Charter with a professional skipper: in this case, the person who rented the vessel does not operate it independently; instead, a person with a valid licence and experience does so. This service is suitable for those who wish to sail but are not ready or able to take on this responsibility.
- Cabin charter: Instead of renting the entire vessel, it is possible to rent a cabin and share the vessel with others. The route is predetermined, and the service usually includes a professional skipper and basic service.
- Crewed charter: in addition to the skipper, there are also other crew members on board, such as a hostess, chef, or sailor. Guests can fully enjoy their holiday while the crew handles all logistical and technical tasks.

Initially, motorboats were mainly rented, but today charter includes all types of vessels, from sailing boats for cruising or regattas, to catamarans, motorboats, yachts, and megayachts, which have been represented on a smaller scale, especially in recent years. The service of renting a vessel in nautical tourism can be provided by natural or legal persons if they obtain a decision confirming that the minimum technical conditions for providing tourist vessel rental services have been met. These conditions are defined by the Ordinance (Official Gazette 42/2017) on the requirements that must be met by a vessel and by the natural or legal person carrying out the activity of vessel rental. Charter nautical activity is the newest group of factors in the nautical tourism offer. It is defined as a service within nautical tourism and includes the following: renting berths in nautical tourism ports for the accommodation of vessels and nautical tourists staying on them; renting vessels with or without crew, with or without accommodation services, for the purpose of rest, recreation, and cruising by nautical tourists (charter, cruising, etc.); services for managing the vessels of nautical tourists; reception, storage, and maintenance of vessels at sea and in dry berths; services for supplying nautical tourists (water, fuel, food, spare parts, equipment); arranging and preparing vessels; providing various

information to nautical tourists (weather forecasts, nautical guides); and other services required for nautical tourism. A nautical charter company owns and manages a fleet of vessels that it offers directly for charter, whereas a nautical charter agency acts as an intermediary between clients and various charter companies to find the best solution for the clients' needs. The operation of charter companies is highly specific, complex, and risky. It is important to determine the size of the owned fleet, particularly based on experience from the previous or current season, as well as expectations for the following season (Gračan et al., 2011). The organisation of a charter company depends on its size and the scope of its services. Some charter companies offer only their own fleet to direct clients or agencies, while others, in addition to their own fleet, also offer vessels from other charter companies in the role of an agency. Besides vessel rental, many charter companies also represent specific manufacturers of new or used vessels or are involved in the resale of used vessels from various manufacturers (Luković et al., 2024). The success of a charter company, as well as that of a nautical tourism port, in addition to effective organisational planning, investment planning, and fleet formation, also greatly depends on the level of modernisation, the condition of the vessels, and the physical performance of the company's employees.

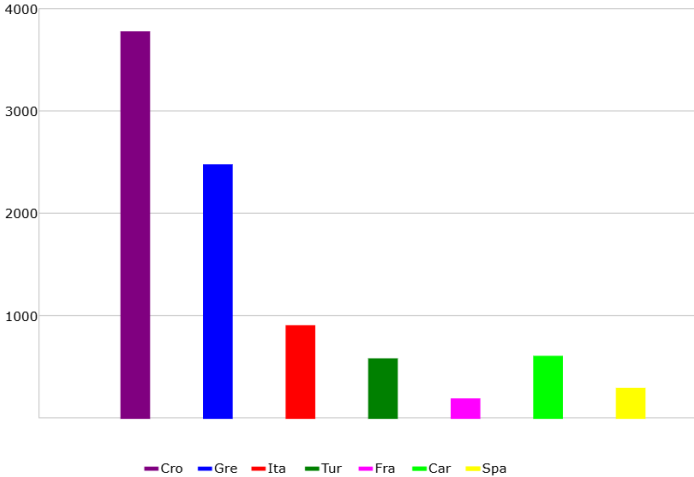
3. CURRENT TRENDS IN THE YACHT CHARTER INDUSTRY

An analysis of charter activity in the Mediterranean (HTZ & Yacht Rent, 2025) in recent years shows that the fleet is expanding more rapidly than demand, raising several questions: from the sustainability of prices and product differentiation to responsibility for attracting new guests. The charter industry will struggle to generate new demand unless it offers greater flexibility and a broader range of services at the destination. Trends indicate that charterers now expect more choice – such as different embarkation days, shorter rental periods, customised packages, and clear rules applicable to all market participants. The product has become too monotonous, restricted to weekly cycles and overly dependent on Saturday check-ins, while demand is expected to grow and a destination product tailored to this segment is lacking. Before analysing the key indicators of the charter industry in the Mediterranean, it is necessary to highlight the changes in charter demand. The results of the latest available data on the attitudes and consumption patterns of boaters are presented below, with a particular focus on trends in the charter industry (*TOMAS NAUTIKA*, 2022). Although the research was conducted in the Republic of Croatia, the data indicate key factors for the entire industry in the Mediterranean. Notably, a large percentage of all charterers (as much as 35%) were on a charter for the first time. Notably, charterers choose Croatia due to the attractiveness of its waters, the sense of security in the country and the safety of navigation, the quality of charter vessels, environmental preservation, and the favourable price of charter vessels. The quality of the charter vessel, environmental preservation, and favourable pricing are the main reasons for selecting a destination. Forty-nine percent rely on previous experience, while 47% use various online sources. The potential for industry development is evident in the fact that a large number of charterers (62%) arrived and departed by personal vehicle, and 29% by aeroplane. As many as 64% of charterers book a vessel through a charter company or agent, with 42.5% doing so online, and 18% using online reservation platforms. Thus, regardless of the method of contact, a total of 64% of charterers booked a vessel through a charter company or agent. It is notable that more than half of charterers (54%) rent a vessel with a skipper or crew. Slightly fewer (46%) rent a vessel without a skipper (bareboat charter), with 3% subsequently hiring a skipper. Fewer than 1% of boaters are part of a charter fleet. Comparing the data to previous years shows that the proportion of charterers renting vessels with a skipper or crew continues to increase (22% in 2012, 44% in 2017, 54% in 2022).

Skipper services are mainly booked through a charter company, and in line with the growth in the share of boaters renting vessels with a skipper or crew, the proportion of boaters using the services of a hired skipper is also steadily increasing (18% in 2012, 34% in 2017, 43% in 2022). The trend of decreasing average length of stay for boaters, observed in 2017 when the length of stay compared to 2012 was reduced by two nights, continues. In 2022, the average length of stay for boaters was reduced by almost two nights compared to 2017, for charterers from 8.0 to 7.3 nights. At the same time, the share of overnight stays in marinas decreased (from 59% in 2017 to 49% in 2022), while the share of overnight stays in ports open to public traffic, at buoys, and at anchor increased. Average daily expenses of charter boaters increased nominally by 39% in 2022 compared to 2017. Skipper expenses rose by 70%, due to increased use of skipper and crew services in 2022 compared to 2017. According to the latest data, the charter market is clearly expanding its user base, but boaters are staying on vessels for shorter periods, with the average length of stay upon arrival decreasing by more than one night compared to last year. Nautical activities maintain a stable share of total overnight stays, but there is an increasingly evident shift towards shorter, more intensive stays. The following presents data on the state of the charter rental market for the 2026 season, based on an analysis of actual data on prices and occupancy. The report used an aggregated dataset from the Yacht Rent system, which currently contains information on more than 9,242 vessels worldwide.

4. CHARTER TOURISM: AN ANALYTICAL PERSPECTIVE

For this report, data from the Yacht Rent system, an online aggregator of charter offers in Europe, was used. Yacht-Rent operates in the field of nautical tourism, with a primary focus on brokerage and organization of yacht charter services in the Republic of Croatia and across the wider Mediterranean region. The company’s portfolio encompasses a broad range of vessels intended for recreational and tourism-related cruising, including sailing yachts, catamarans, motor yachts, speedboats, gulets, and mega yachts. The company’s activities are not limited to the Croatian market but also extend to other Mediterranean destinations, including Greece, Italy, Turkey, Malta, France, and Spain. Vessels are available in major nautical regions across these countries. Furthermore, the company offers yacht charter services in more distant and exotic destinations, such as the Caribbean, thereby expanding its portfolio into the global nautical tourism market. According to the source used, the system records a total of 9,242 vessels from all over the world available for charter for the 2026 season.



*Chart 1: Number of yachts/boats for charter in 2026
Source: Yacht-Rent, 20.01.2026*

https://www.yacht-rent.com/yacht-charter-statistics-charts#chart_titleNUM

For the 2026 season, the average weekly charter rate amounts to 5,488 €, calculated from a selection of 9,242 yachts and boats in Yacht-Rent portfolio. Peak pricing occurs during the week starting 1 August 2026, when the average rate reaches 7,731 €, while the most affordable period is the week beginning 12 December 2026, with an average price of 4,426 €. Overall, charter costs in the low season can be as much as 43% lower than during the peak season.

Country	Highest	Average	Lowest	Lo/Hi
Cro 3768 Boats	7,134€ (2026-08-01)	4,810€	3,729€ (2026-04-04)	↓48%
Gre 2468 Boats	8,112€ (2026-08-01)	5,323€	3,797€ (2026-03-21)	↓53%
Ita 895 Boats	9,760€ (2026-08-08)	5,979€	4,960€ (2026-11-07)	↓49%
Tur 571 Boats	8,261€ (2026-08-15)	6,774€	5,723€ (2026-03-21)	↓31%
Car 596 Boats	13,156€ (2026-12-19)	8,860€	6,121€ (2026-09-26)	↓53%
Spa 283 Boats	8,509€ (2026-08-08)	5,590€	4,492€ (2026-03-14)	↓47%
Boats:9242				

Table 1: Average charter price of a yacht/boat in 2026
Source: Yacht-Rent, 20.01.2026

https://www.yacht-rent.com/yacht-charter-statistics-charts#chart_titleNUM

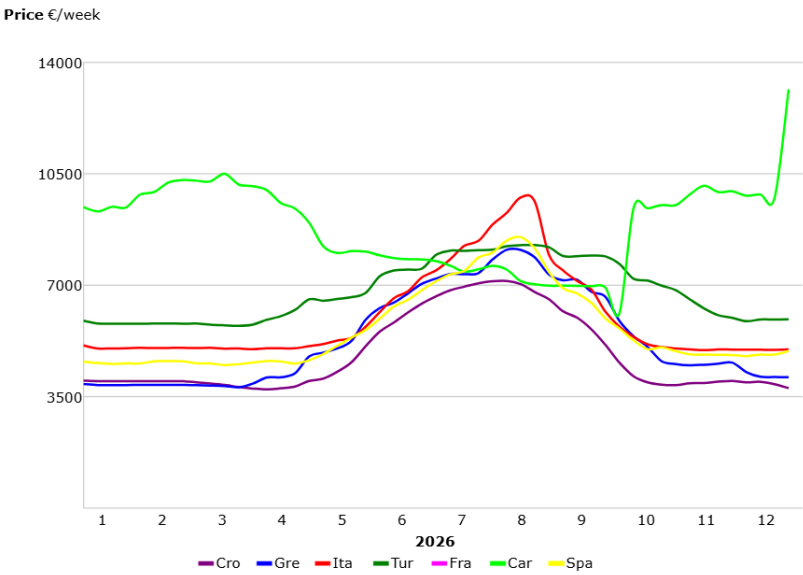


Chart 2: Average charter price of a yacht/boat by month in 2026
Source: Yacht-Rent, 20.01.2026

https://www.yacht-rent.com/yacht-charter-statistics-charts#chart_titleNUM

In 2026, the average weekly cost of renting a yacht or boat per person comes to 581 €. This figure is based on 9,242 vessels in Yacht-Rent fleet and is calculated by dividing each vessel’s average charter price by the maximum number of guests it can accommodate.

Country	Highest	Average	Lowest	Lo/Hi
Cro 3768 Boats	776€ (2026-08-01)	529€	416€ (2026-04-04)	↓46%
Gre 2468 Boats	824€ (2026-08-01)	545€	390€ (2026-03-21)	↓53%
Ita 895 Boats	990€ (2026-08-08)	615€	510€ (2026-11-07)	↓48%
Tur 571 Boats	900€ (2026-08-15)	747€	630€ (2026-03-21)	↓30%
Car 596 Boats	1,391€ (2026-12-19)	889€	614€ (2026-09-26)	↓56%
Spa 283 Boats	878€ (2026-08-08)	589€	479€ (2026-03-14)	↓45%
Boats:9242				

Table 2: Average yacht/boat rental prices per person
Source: Yacht-Rent, 20.01.2026

https://www.yacht-rent.com/yacht-charter-statistics-charts#chart_titleNUM

The highest average price per person is recorded in the week starting 1 August 2026, reaching 809 €, while the lowest occurs in the week beginning 19 December 2026, at 475 €. Overall, the gap between peak and off-season rates amounts to a reduction of up to 41%.

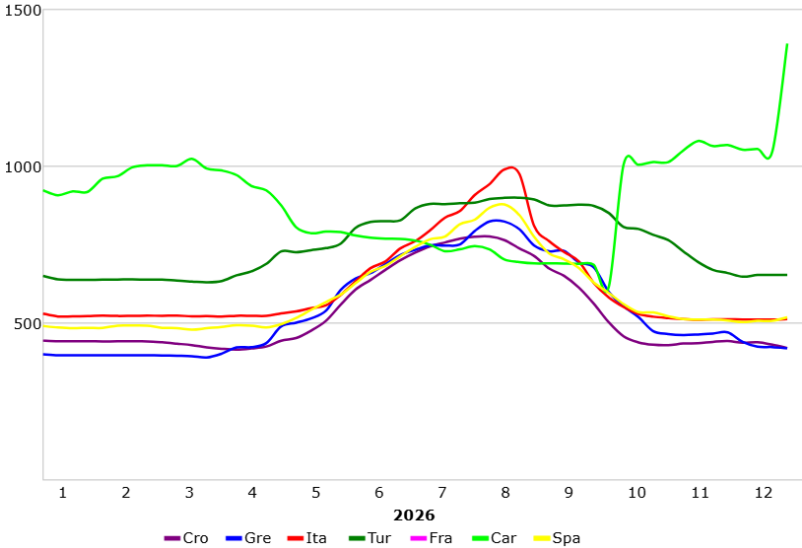


Chart 3: Average yacht/boat rental prices per person by month in 2026
Source: Yacht-Rent, 20.01.2026

https://www.yacht-rent.com/yacht-charter-statistics-charts#chart_titleNUM

In 2026, the average booking rate for yacht and boat rentals is 24.24% of the year (about 12 weeks), based on data from 7,207 vessels in our listings that have been updated within the past week. The highest occupancy occurs during the week of May 30, 2026 (42.39%), while the lowest is during the week of November 7, 2026 (4.06%). Small discrepancies may appear in the data at the beginning and end of the season, as certain boat owners record maintenance periods as guest reservations, which can artificially increase the reported booking rate.

Country	Highest	Average	Lowest	Weeks
Cro 3078 Boats	44.7% (2026-05-30)	17.89%	2.38% (2026-10-31)	9
Gre 1899 Boats	47.91% (2026-05-30)	31.14%	4.55% (2026-11-07)	16
Ita 493 Boats	48.98% (2026-05-30)	16.72%	4.98% (2026-12-19)	9
Tur 393 Boats	36.92% (2026-05-02)	11.38%	0% (2026-12-19)	6
Car 484 Boats	82.23% (2026-01-03)	32.97%	0.26% (2026-10-17)	17
Boats:7207				

Table 3: Average rental booking rate of a yacht/boat
Source: Yacht-Rent, 20.01.2026

https://www.yacht-rent.com/yacht-charter-statistics-charts#chart_titleNUM

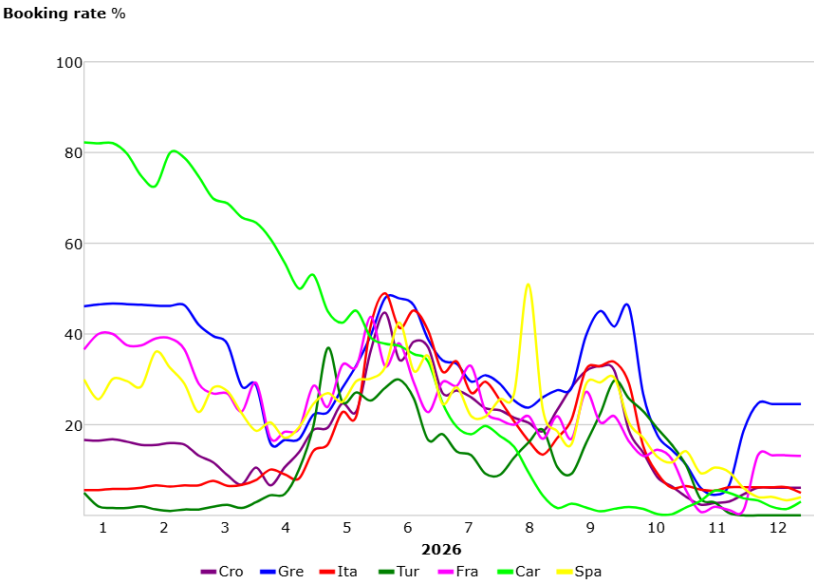


Table 4: Average rental booking rate of a yacht/boat by month in 2026
Source: Yacht-Rent, 20.01.2026

https://www.yacht-rent.com/yacht-charter-statistics-charts#chart_titleNUM

Based on the analysis, it is possible to conclude that charter tourism in 2026 shows pronounced seasonal variations in both pricing and occupancy. Average weekly charter rates range from €4,426 in December to €7,731 in August, while per-person costs vary between €475 and €809. Booking rates peak in late May and drop to minimal levels in early November, highlighting the strong seasonality that shapes charter operations and planning.

5. CONCLUSION

Can the price of a boat be the same in all Mediterranean countries, and must the strategy of lowering boat prices take into account the characteristics of a particular destination, costs, and demand dynamics? The main mistake of the entire charter industry was attempting to "cover costs by lowering prices", which led to situations where a vessel is sometimes cheaper than it should be. Different regions have different costs – from marinas to management fees – so it is logical that the same type of vessel costs more in one destination and less in another. The problem arises when the pricing strategy collapses under the pressure to lower prices, because once prices have been reduced, it is almost impossible to return them to a realistic level. This is precisely why the market should protect the "lowest sustainable price", even though a certain segment of the market does not respond to price at all. There are customers who choose a charter company for its brand, the destination, the type of vessel, or the well-known service, rather than the lowest price. As a result, the industry focuses too much on those seeking the lowest price, instead of those seeking quality. The study provides a detailed statistical analysis of weekly charter rates and per-person costs across a large fleet of 9,242 yachts and boats, highlighting peak and off-season differences of up to 43% in total rates and 41% per person. By examining booking rates across 7,207 vessels, the research identifies temporal fluctuations in demand, showing peak occupancy in late May (42.39%) and minimal levels in early November (4.06%), offering insights into the seasonal dynamics of charter tourism. The findings support informed decision-making for operators and clients, enabling optimized pricing strategies, fleet management, and planning for high- and low-demand periods.

ACKNOWLEDGEMENT: *This work has been fully supported by the University of Rijeka project ZIP-FMTU-3-5-2024 "SPECIFIC CHALLENGES AND TRENDS THAT AFFECT THE SUCCESS OF CHARTER ACTIVITIES IN NAUTICAL TOURISM" and UNIRI-IZ-25-260 "THREE DIMENSIONS OF TOURISM SUSTAINABILITY"*

LITERATURE:

1. Alcover, A., Alemany, M., Jacob, M., Payeras, M., García, A., & Martínez-Ribes, L. (2011). The economic impact of yacht charter tourism on the Balearic economy. *Tourism Economics*, 17(3), 625–638.
2. Čarter.hr. (n.d.). *Rent a boat vs. nautički charter*, <https://www.xn--arter-gya.hr/trendovi/rent-a-boat-vs-nauticki-charter>
3. Diakomihalis, M. N. (2007). Greek maritime tourism: Evolution, structures and prospects. *Research in Transportation Economics*, 21, 419–455.
4. Gračan, D., Bardak, G., & Rudančić-Lugarić, A. (2011). The research results of charter companies in Croatia. *Tourism and Hospitality Management*, 17(1), 19–34.
5. Luković, T. (2007). Nautički turizam: Defininiranje i razvrstavanje. *Ekonomski pregled*, 58(11), 689–708.
6. Luković, T. (2012). Nautical tourism and its function in the economic development of Europe. U *Visions for global tourism industry – Creating and sustaining competitive strategies* (str. 19).

7. Luković, T., & Gržetić, Z. (2007). *Nautičko turističko tržište u teoriji i praksi Hrvatske i europskog dijela Mediterana*. Split: Hrvatski hidrografski institut.
8. Luković, T., Barkidija Sotošek, M., Gračan, D., Bukša, J., Jugović, A., Zec, D., Kundih, B., Marušić, E., Petrinović, R., & Mandić, N. et al. (2024). *Nautical tourism in Croatia*. Split: Redak.
9. Official Gazette. (2017). *Regulation on the conditions for performing activities of renting vessels with or without crew and providing accommodation services on vessels* (No. 42/2017).
10. Official Gazette. (2010). *Act on the Provision of Services in Tourism* (No. 68/07).
11. Russo, F., & Rindone, C. (2022). Aggregate models for planning nautical tourism: Basic, trend and seasonal demand. *Case Studies on Transport Policy*, 10(4), 1980–1987.
12. TOMAS Nautika. (2023). *Stavovi i potrošnja nautičara u Hrvatskoj u 2022. godini: Završni izvještaj*. Zagreb: Institut za turizam.
13. Yacht-Rent. (2026). *Yacht charter statistics charts*.
<https://www.yacht-rent.com/yacht-charter-statistics-charts>

LABOUR MARKET TIGHTNESS AND SHIFTS IN THE BEVERIDGE CURVE IN THE EUROPEAN UNION FROM 2016 TO 2024

Sofija Turjak

*J. J. Strossmayer University of Osijek, Faculty of Economics and Business in Osijek, Croatia
Trg Lj. Gaja 7, Osijek
: sofija.turjak@efos.hr*

ABSTRACT

The labour market in the European Union in the period 2016–2024 has overcome two consecutive, but different in nature, macroeconomic shocks: the COVID-19 pandemic shock in 2020 and the energy price shock in 2021–2022. While the pandemic shock had an immediate and strong impact on employment and economic activity, the energy shock had a mainly indirect effect, through cost growth, sectoral heterogeneity, and changes in the structure of labour demand. This difference in the nature of the shocks is crucial for correctly interpreting the shifts in the Beveridge curve and changes in labour market tightness. The Beveridge curve shows the inverse relationship between the unemployment rate and the job vacancy rate. Using quarterly panel data on unemployment rates and job vacancy rates from Eurostat, the paper applies descriptive analysis, graphical inspection of Beveridge curves, and fixed-effects panel regressions to assess whether the relationship between unemployment and vacancies has changed over time. The results indicate a statistically significant outward shift of the Beveridge curve in the post-pandemic period, suggesting a decline in matching efficiency and an increase in structural mismatch in EU labour markets. While the pandemic shock had a direct and short-lived impact on employment, the energy price shock appears to have reinforced labour market tightness through sectoral reallocation rather than through higher unemployment. The results show the growing importance of structural factors in shaping labour market outcomes, as well as the changes in labour market and skills policies in the EU.

Keywords: *labour market, Beveridge curve, unemployment, job vacancies*

1. INTRODUCTION

The European Union labour market has been marked by a series of strong and interconnected shocks in the last decade, most notably the COVID-19 pandemic and the energy crisis that began in 2021. These events have significantly affected the dynamics of labour supply and demand, raising the question of whether changes in key labour market indicators are cyclical or indicative of broader structural changes. In this context, the Beveridge curve, which describes the negative relationship between the unemployment rate and the job vacancy rate, has emerged as a central analytical framework for studying the functioning of the labour market. The aim of this paper is to empirically examine changes in the Beveridge ratio at the European Union level from 2016 to 2024, with a particular focus on the periods following the COVID-19 pandemic and the energy crisis. The analysis is based on panel data for 17 EU member states, quarterly, combining descriptive analysis of Beveridge curves with econometric analysis using fixed-effects models. The paper proposes two research hypotheses. The first hypothesis (H1) examines whether the COVID-19 pandemic has shifted the Beveridge curve's slope, i.e., the relationship between unemployment and job vacancies. The second hypothesis (H2) examines the effects of the energy crisis and post-pandemic recovery on labour market tightness, aiming to determine whether structural labour market tensions have further intensified after 2021. The paper's contribution lies in combining a graphical and a regression approach, enabling the distinction between cyclical movements and potential structural changes in the EU labour market. This paper builds on the existing literature on the Beveridge curve and provides new empirical insights into recent trends characterised by extraordinary macroeconomic shocks.

2. LITERATURE REVIEW

The Beveridge curve is a fundamental concept in labour market analysis, as it describes the negative relationship between the unemployment rate and the vacancy rate. It was originally introduced by Beveridge (1944), and later literature developed a theoretical framework that relates the shape and shifts of the curve to the efficiency of the labour supply-demand matching process (Pissarides, 2000). In the standard model of search and matching in the labour market, movement along the Beveridge curve is interpreted as a cyclical phenomenon, while shifts in the curve itself signal structural changes in labour-market functioning. A significant part of the empirical literature aims to identify the factors that cause shifts in the Beveridge curve. Blanchard and Diamond (1989) show that changes in the separation rate, the match efficiency, and the labour market's institutional characteristics can lead to an upward or downward shift in the curve. Similarly, Nickell, Nunziata and Ochel (2005) highlight the importance of institutional factors, such as employment protection and labour market policies, in explaining differences in the Beveridge relationship across countries. In the context of European labour markets, numerous studies emphasise the pronounced heterogeneity among member states. Bonthuis, Jarvis and Vanhala (2016) analyse Beveridge curves for euro area countries and conclude that differences in their shape and dynamics can be largely attributed to structural differences and different speeds of labour market adjustment to economic shocks. Similarly, Hobijn and Şahin (2013) show that changes in labour market tightness can reflect both cyclical and structural factors, especially after major recessions. The COVID-19 pandemic has introduced a new character into the literature, examining its impact on labour markets and the Beveridge curve. Barrero, Bloom, and Davis (2021) analyse a significant increase in labour market tightness in the post-pandemic period, accompanied by a concomitant rise in job vacancies and a relatively rapid recovery in employment. The authors point out that such patterns may indicate changes in workers' preferences, sectors of demand, and geographic patterns of work. In the European context, the ECB (2022) and Eurostat (2023) report an upward shift in the Beveridge curve across several member states, suggesting reduced efficiency in matching labour supply and demand after the pandemic. In addition to the pandemic, the energy crisis and inflationary pressures after 2021 have further complicated labour market dynamics. Recent literature suggests that energy shocks have had an uneven impact on European labour markets, depending on countries' energy dependence and the structure of their economies (Arce et al., 2023). Although there is relatively little work directly linking the energy crisis to changes in the Beveridge curve, a growing number of studies emphasise the importance of analysing labour market tightness as a complementary indicator of structural tensions. Empirically, most papers studying the Beveridge relationship use panel data and fixed-effects models to control for unobserved cross-country heterogeneity (Elsby, Michaels, & Solon, 2009). The Hausman test is often used to select between fixed and random effects, and in macro-panels with countries as units of observation, the fixed-effects model is most often justified. Also, recent literature increasingly emphasises the importance of combining graphical and regression analyses to avoid misinterpretation based solely on one approach.

3. METHODOLOGY

The empirical analysis is based on panel data from Eurostat for 17 European Union Member States, covering the period 2016 to 2024 and quarterly observations. Due to data unavailability, the following countries were excluded from analysis: Austria, Belgium, Cyprus, Denmark, France, Greece, Ireland, Italy, Malta, and Spain. Such a data structure enables detailed monitoring of labour market dynamics and the identification of changes related to the COVID-19 pandemic and the energy crisis. The sample consists of a balanced panel with 36 observations per country.

The following variables are used in the analysis: unemployment rate (UR), job vacancy rate (JVR), and labour market tightness, defined as the ratio of the job vacancy rate to the unemployment rate (OECD, 2023). All variables refer to the aggregate level of an individual country. The analysis is conducted in two complementary stages. First, descriptive and graphical analysis of the Beveridge curve is applied to visually examine the dynamics of the relationship between unemployment and job vacancies over different time periods. Second, graphically observed patterns are formally tested using panel econometric models that control for unobserved heterogeneity across countries and common time shocks.

Four regression models are estimated for empirical testing of the set of hypotheses.

Model M1: Main specification (H1 testing)

$$JVR_{i,t} = \alpha_i + \lambda_t + \beta_1 UR_{i,t} + \beta_2 PostCOVID_t + \beta_3 (UR_{i,t} * PostCOVID_t) + \varepsilon_{i,t}$$

In this model, the dependent variable is the job vacancy rate ($JVR_{i,t}$) in country i and in period t . The variable $UR_{i,t}$ denotes the unemployment rate, while $PostCOVID_t$ is an indicator of the post-pandemic period. The interaction term allows examining the change in the Beveridge curve's slope after the COVID-19 pandemic. The parameter α_i represents country fixed effects, λ_t time fixed effects at the quarterly level, and $\varepsilon_{i,t}$ random error.

Model M2: Robustness – exclusion of pandemic year 2020 (H1 testing)

$$JVR_{i,t} = \alpha_i + \lambda_t + \beta_1 UR_{i,t} + \beta_2 PostCOVID_t + \beta_3 (UR_{i,t} * PostCOVID_t) + \varepsilon_{i,t}, t \neq 2020$$

The M2 model is identical to the Model M1 but is estimated on a sample excluding the pandemic year 2020. This specification serves as a robust check to determine whether the results in Model M1 are driven by extreme pandemic shocks or reflect broader post-pandemic changes.

Model M3: Energy Channel (testing H2 testing)

$$JVR_{i,t} = \alpha_i + \lambda_t + \beta_1 UR_{i,t} + \beta_2 PostEnergy_t + \beta_3 (UR_{i,t} * PostEnergy_t) + \varepsilon_{i,t}$$

Model M3, the post-pandemic period indicator is replaced by a post-energy period indicator ($PostEnergy_t$), which takes on the value of 1 from the first quarter of 2022 onwards. The aim of this model is to examine whether the energy crisis has further changed the relationship between unemployment and job vacancies.

Model M4: Labour market tightness by period (H2 testing)

$$Tightness_{i,t} = \alpha_i + \lambda_t + \beta_1 UR_{i,t} + \sum_{k=1}^3 \delta_k Period_{k,t} + \varepsilon_{i,t}$$

In this model, the dependent variable is labour market tightness, defined as the ratio of the job vacancy rate to the unemployment rate.

The variable $Period_{k,t}$ represents indicators for the pandemic year 2020, the period 2021–2022 and the period 2023–2024, while the period 2016–2019 is the reference category. The coefficients δ_k measure the deviation of labour market tightness from the pre-pandemic period. To select the appropriate panel model, a Hausman test was conducted. The Hausman test rejects the null hypothesis of unsystematic differences in coefficients ($\chi^2 = 47.64, p = 0.014$), indicating a correlation between individual effects and regressors. Consequently, fixed-effects models are used to test all models. All models also include quarterly time fixed effects to control for common macroeconomic shocks. The estimation uses clustered standard errors at the country level, which ensures robust statistical inference in the presence of heteroscedasticity and serial correlation within the panel. The results remain stable across alternative model specifications, further confirming the robustness of the findings.

4. RESULTS

The results are presented through a combination of graphical representations of the Beveridge curve and panel-data fixed-effects regression estimates. Such an approach allows for the simultaneous observation of descriptive patterns and formal testing of the research hypotheses.

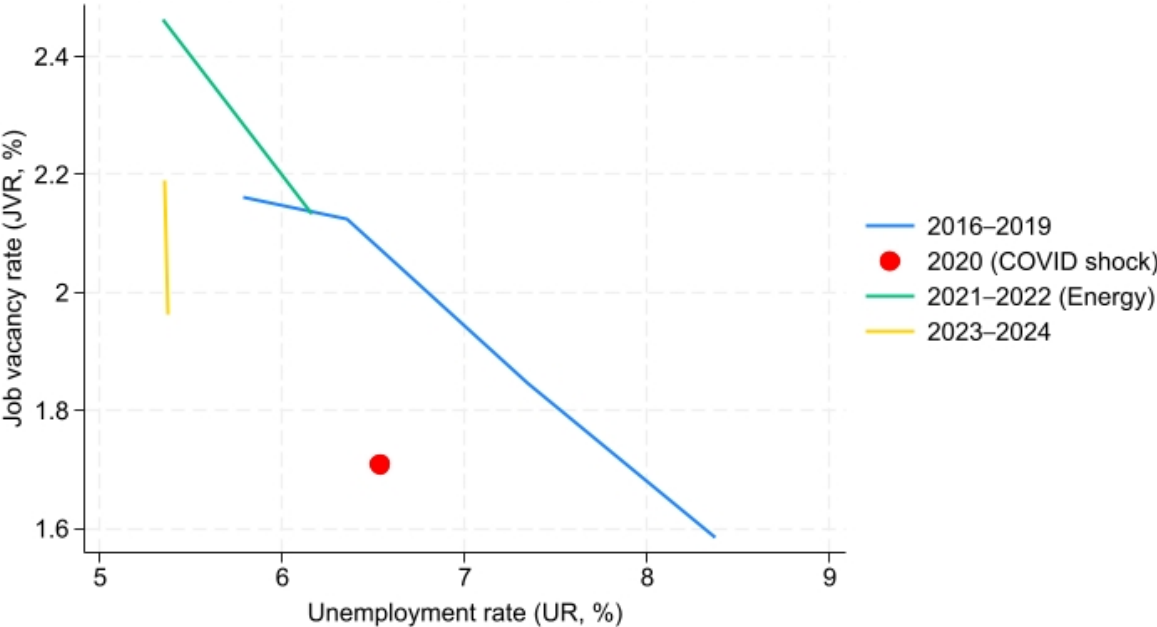


Figure 1: Beveridge curve – EU17 average by periods
(Source: the author’s own calculation)

Figure 1 shows the Beveridge curve for the EU17 average, with the UR on the horizontal axis and the JVR on the vertical axis. Different periods are marked by separate lines or dots to highlight changes in the relationship between unemployment and job vacancies. A clear downward-sloping Beveridge curve is observed during 2016–2019, indicating the usual negative relationship between the unemployment rate and the job vacancy rate in conditions of stable economic growth and improving labour market conditions. The year 2020, marked by the COVID-19 pandemic, is shown as a separate dot. It is located lower on the job vacancy axis and at a relatively higher unemployment rate compared to the previous period, reflecting the sudden negative shock to the labour market and the sharp decline in labour demand during the pandemic.

In the period 2021–2022, which covers the recovery from the pandemic and the onset of the energy crisis, the curve shifts upward and to the left, indicating a sharp increase in the job vacancy rate while unemployment decreases. This shift suggests increased labour market tensions and the possible emergence of structural mismatches between labour supply and demand. In the latest period 2023–2024, the curve is short and relatively steep, indicating a stabilisation of the labour market with a continued high level of job vacancies and more moderate changes in unemployment. This indicates a gradual easing of previous shocks, but also the persistence of certain structural pressures in the EU labour market.

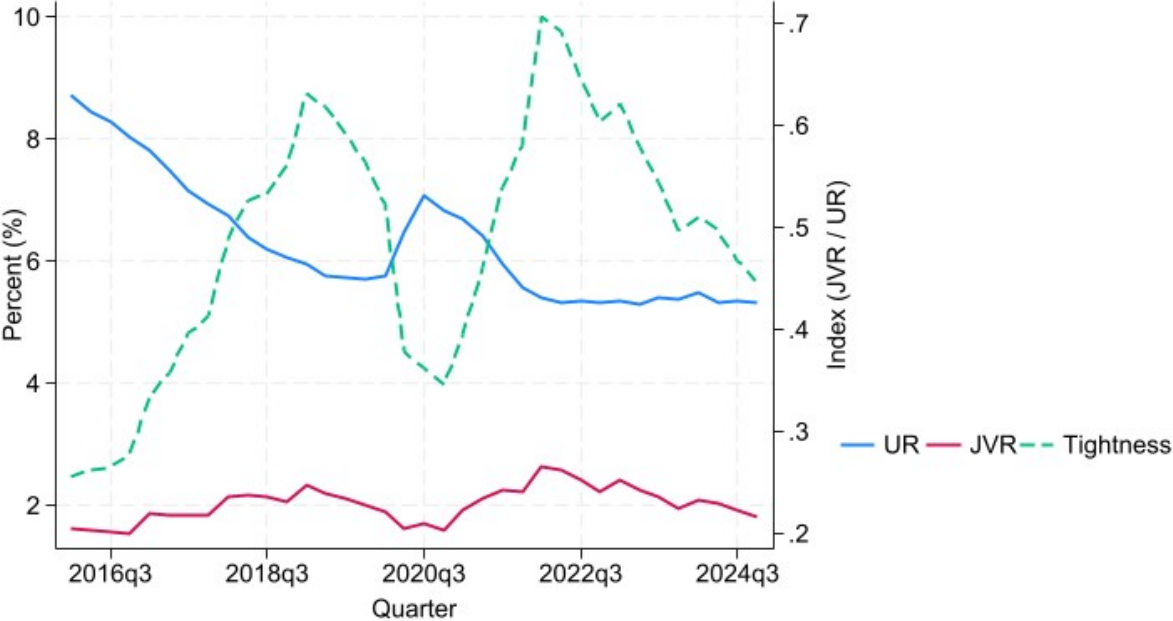


Figure 2: UR, JVR and labour market tightness over time (EU17 average)
 (Source: the author’s own calculation)

Figure 2 shows the development of the UR, the JVR and the labour market for the EU17 average at a quarterly level. The unemployment and job vacancy rates are shown on the left vertical axis, while the labour market tightness index is shown on the right axis. From 2016 to the beginning of 2020, the unemployment rate declined continuously, while the job vacancy rate rose gradually. As a result of such developments, labour market tightness gradually increased, indicating a strengthening of labour demand and increasingly favourable conditions during the pre-pandemic period. During 2020, there was a pronounced break in the previous trend. The unemployment rate temporarily increases while the job vacancy rate decreases, leading to a sharp drop in labour market tightness. This pattern clearly reflects the negative shock caused by the COVID-19 pandemic and the sharp deterioration in labour market conditions. In the recovery phase during 2021 and 2022, the unemployment rate decreases again, while the job vacancy rate increases strongly, reaching historically high levels. As a result, labour market tightness increases sharply and peaks, indicating extremely strong labour demand, limited labour supply, and increased difficulty in filling job vacancies. In the most recent period, from 2023 to 2024, the unemployment rate stabilised at relatively low levels, while the job vacancy rate gradually decreased. This reduces labour market tightness and eases labour market pressures, although it remains tighter than in the pre-pandemic period. The movements in the unemployment rate, the job vacancy rate and the labour market tightness shown in Figure 2 are directly reflected in the shifts along and across the Beveridge curve itself.

The pre-pandemic period is characterised by a simultaneous decline in unemployment and an increase in the job vacancy rate, corresponding to a movement along the downward slope of the Beveridge curve and indicating a cyclical improvement in labour market conditions. The pandemic shock in 2020 manifests as an unexpected break in previous trends, with rising unemployment and falling job vacancy rates, which, on the Beveridge curve, represent an upward and rightward shift, i.e., a temporary departure from the long-run equilibrium. This shift reflects an extraordinary shock, rather than a change in the underlying efficiency of the matching of labour supply and demand. In 2021–2022, the simultaneous decline in unemployment and a strong increase in the job vacancy rate led to an upward shift of the Beveridge curve, consistent with the sharp increase in labour market tightness shown in Figure 2. Such a shift may indicate increased structural tensions and reduced labour market adjustment efficiency. In the most recent period, the gradual decline in the job vacancy rate, coupled with stabilisation in unemployment, has led to a slight return of the Beveridge curve to lower levels, suggesting a partial easing of previous disruptions, but without a full return to the pre-pandemic configuration.

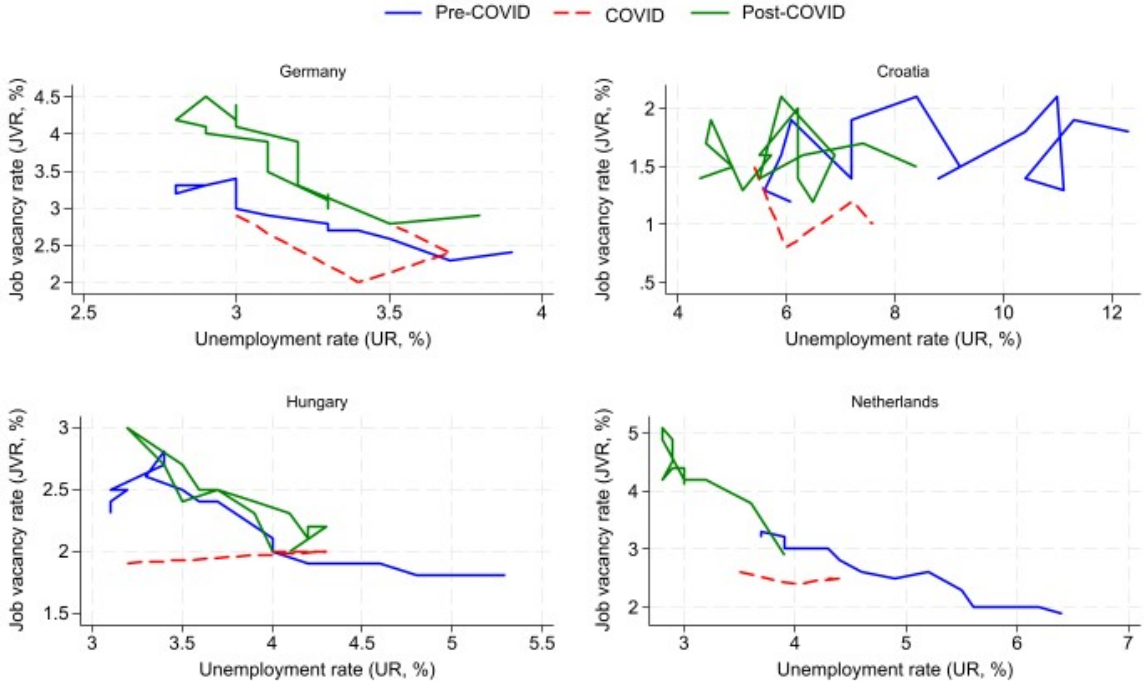


Figure 3: Beveridge curves for selected EU countries
(Source: the author’s own calculation)

Figure 3 shows the Beveridge curves for Germany, Croatia, Hungary and the Netherlands, constructed as quarterly paths in the space of the unemployment rate and the job vacancy rate. Different periods are marked in colours: pre-pandemic (Pre-COVID), pandemic (COVID), and post-pandemic (Post-COVID), which provide insight into the dynamic changes in the relationship between unemployment and labour demand. In Germany, a downward Beveridge curve is observed in the pre-pandemic period, reflecting both a decrease in unemployment and a relatively high level of job vacancies. During the pandemic, there is a temporary shift towards higher unemployment and a lower job vacancy rate, while in the post-pandemic period, the curve shifts upwards, with higher job vacancies at comparable unemployment levels, which may indicate increased tightness and possible structural mismatches in the labour market. In Croatia, the relationship between unemployment and job vacancies is more volatile.

The pre-pandemic period is characterised by a decline in unemployment with a moderate increase in job vacancies. The pandemic period shows a short-term deterioration, while the post-pandemic period sees an increase in job vacancies with relatively higher unemployment, indicating a gradual tightening of the labour market, but with pronounced fluctuations. In Hungary, a stable inverse relationship between unemployment and job vacancies is evident in the pre-pandemic period. During the pandemic, changes are relatively moderate, while in the post-pandemic period, the curve shifts slightly upwards, suggesting increased labour demand at given unemployment levels. A strong Beveridge curve dynamic is clearly visible in the Netherlands. The pre-pandemic period is characterised by high job vacancies and low unemployment. The pandemic shock causes a short-term deterioration, while in the post-pandemic period, the curve shifts upwards, with exceptionally high job vacancies and low unemployment, indicating a particularly tight labour market. The trends shown in Figure 3 are consistent with the aggregated Beveridge curve for the EU average, but they also show that the aggregated pattern arises from heterogeneous national trajectories. The aggregated EU curve summarises the general negative relationship between unemployment and job vacancies, with a shift towards higher job vacancy rates in the post-pandemic period, when unemployment is relatively low, indicating increased labour market tightness at the EU level. The panel for Germany and the Netherlands suggests that these countries are making a significant contribution to the post-pandemic “upward shift” of the aggregated Beveridge curve, as they record high job vacancies in the post-COVID period alongside low unemployment rates. On the other hand, the more volatile and moderate trajectories of Croatia and Hungary suggest that part of the changes at the aggregate EU level may also reflect differences in the speeds of recovery, sectoral structure and efficiency of labour supply and demand matching across Member States. Therefore, the aggregated EU Beveridge curve can be interpreted as an average representation of labour market dynamics, while national curves provide additional insight into whether aggregate shifts are primarily cyclical (movement along the curve) or reflect deeper structural changes (shifts of the curve itself) that manifest themselves with different intensity in different countries.

Variable	Coefficient	Robust SE	p-value	Variable	Value
Unemployment rate (UR)	-0.0256	0.0596	0.674	Observations	612
Post-COVID	0.2441	0.6154	0.697	Countries	17
UR * PostCOVID	-0.0263	0.0966	0.789	Within R ²	0.303

*Table 1: Main specification: Beveridge relationship after COVID-19 (H1)
(Source: the author’s own calculation)*

Table 1 presents the main specification of the fixed-effects model, which tests the first research hypothesis (H1) regarding changes in Beveridge's relationship after the COVID-19 pandemic. The coefficient on the unemployment rate is negative, consistent with the theoretical expectations of the Beveridge curve, but is not statistically significant ($p = 0.674$). Also, neither the indicator of the post-pandemic period ($p = 0.697$) nor the interaction term between unemployment and the post-COVID period ($p = 0.789$) is statistically significant. These results suggest that, after controlling for country- and time-fixed effects, there is no empirical evidence of a significant change in the slope of the Beveridge curve in the post-pandemic period. Therefore, hypothesis H1 cannot be confirmed in the main regression specification. Given the potential distortions from the extreme shock in 2020, the next step is to perform a robustness check by excluding that year from the sample.

Variable	Coefficeint	Robust SE	p-value	Variable	Value
Unemployment rate (UR)	-0.0180	0.0616	0.774	Observations	544
Post-COVID	0.3331	0.5833	0.576	Countries	17
UR * PostCOVID	-0.0403	0.0897	0.659	Within R ²	0.293

Table 2: Robustness check: excluding the COVID year 2020 (H1)
(Source: the author's own calculation)

Table 2 shows the results of a robustness check in which the pandemic year 2020 is excluded from the sample. The coefficient on the unemployment rate remains negative but statistically insignificant ($p = 0.774$), consistent with the main specification. Also, neither the post-pandemic indicator nor the interaction term between unemployment and the post-COVID period is statistically significant. These results confirm that the lack of regression evidence of a change in the Beveridge curve is not due to an extreme shock in 2020, but rather suggests that changes in the unemployment-job vacancy ratio can largely be attributed to common time effects.

Variable	Coefficeint	Robust SE	p-value	Variable	Value
Unemployment rate (UR)	-0.0298	0.0604	0.629	Observations	612
Post-Energy	0.1687	0.6913	0.810	Countries	17
UR * PostEnergy	-0.0134	0.1142	0.908	Within R ²	0.302

Table 3: Energy channel: Beveridge relationship after 2022Q1 (H2)
(Source: the author's own calculation)

The results of Model M3, shown in Table 3, do not indicate a statistically significant effect of the energy crisis on the relationship between unemployment and job vacancies. The coefficient on the unemployment rate remains negative but insignificant ($p = 0.629$), while the post-energy indicator and the interaction term are both statistically insignificant ($p = 0.810$ and $p = 0.908$). These findings suggest that the energy crisis did not lead to an additional change in the slope of the Beveridge curve at the EU level, even after controlling for country- and time-fixed effects. This does not support hypothesis H2 in the model using JVR as the dependent variable.

Period	Coefficeint	Robust SE	p-value	Variable	Value
2020 (COVID)	0.0899	0.0703	0.219	Observations	612
2021-2022 (Energy)	0.3481	0.1081	0.005	Countries	17
2023-2024	0.1911	0.0771	0.025	Within R ²	0.302

Table 4: Labour market tightness by period (H2)
(Source: the author's own calculation)

Table 4 provides strong empirical support for hypothesis H2. While the pandemic year 2020 does not show a statistically significant effect on the tightness of the labour market ($p = 0.219$), the period 2021–2022 is marked by a strong and statistically significant increase in the tightness of the labour market ($p = 0.005$). In the period 2023–2024, tightness remains statistically significantly higher compared to the pre-pandemic period ($p = 0.025$), although the effect is smaller than in the previous phase. These results point to permanent structural tensions in the EU labour market after the pandemic and the energy crisis. Based on the results of the main specification and robustness tests, hypothesis H1 cannot be confirmed. In the main model, the interaction term between the unemployment rate and the post-pandemic period is not statistically significant, indicating that the Beveridge curve's slope after the COVID-19 pandemic has not changed significantly relative to the pre-crisis period.

A similar result is obtained in the robust specification in which the year 2020 is excluded from the sample, with the interaction coefficient again not being statistically significant. These findings suggest that, despite the visible changes in unemployment and job vacancy rates, there is no empirical evidence of a structural change in the relationship between these two variables in the post-pandemic period. The results for hypothesis H2 indicate partial confirmation, depending on the specification used. In the regression model examining the change in the Beveridge ratio after the onset of the energy crisis, the interaction term between the unemployment rate and the post-energy period is not statistically significant. This does not find evidence that the energy shock led to a change in the slope of the Beveridge curve. However, the analysis of labour market tightness by period shows a different picture. The results in Table 4 indicate a statistically significant increase in labour market tightness during the energy crisis period of 2021–2022 and 2023–2024, compared to the pre-crisis period. These findings suggest that the energy shock affected the labour market primarily through an increase in the level of tightness, i.e. the growth of job vacancies with relatively stable unemployment, and not through a change in the underlying relationship between unemployment and job vacancies.

5. CONCLUSION

The results of the analysis provide a nuanced view of the changes in the European Union labour market in the period following the COVID-19 pandemic and the energy crisis. Descriptive and graphical representations of the Beveridge curve indicate visible shifts in the relationship between unemployment and job vacancies, especially in the post-pandemic period, which, at first, suggest increased labour market tightness and a potential upward shift in the curve. However, regression analysis based on fixed-effects models, controlling for geographical and temporal fixed effects, does not provide strong statistical evidence of a change in the Beveridge curve slope after the pandemic. Key interaction terms in the models linking the unemployment rate and job vacancies remain statistically insignificant, even after excluding the pandemic year 2020 from the sample. Thus, the first research hypothesis cannot be empirically confirmed in the regression framework. On the other hand, the analysis of labour market tightness provides clear and robust evidence in support of the second hypothesis. The results show that labour market tightness in the European Union is statistically significantly higher in 2021–2022 and remains elevated in 2023–2024 compared to the pre-pandemic period. These findings suggest that changes in the labour market during the observed period are primarily structural and cannot be fully explained by cyclical fluctuations. Overall, the paper shows that the graphically observed shifts in the Beveridge curve can largely be attributed to common time shocks affecting all European Union countries, whereas larger structural changes are more clearly manifested in permanently elevated labour market tightness. These results have important implications for the design of labour market policies, as they point to the need for measures that strengthen the efficiency of labour supply and demand matching and reduce structural bottlenecks in the European labour market.

LITERATURE:

1. Arce, O., Koester, G., Nickel, C., & Osbat, C. (2023). *Energy shocks, inflation and the euro area economy*. European Central Bank Economic Bulletin, Issue 2/2023.
2. Barrero, J. M., Bloom, N., & Davis, S. J. (2021). Why working from home will stick. *National Bureau of Economic Research Working Paper No. 28731*. <https://doi.org/10.3386/w28731>
3. Beveridge, W. H. (1944). *Full employment in a free society*. London, UK: George Allen & Unwin.

4. Blanchard, O. J., & Diamond, P. (1989). The Beveridge curve. *Brookings Papers on Economic Activity*, 1989(1), 1–60.
<https://doi.org/10.2307/2534495>
5. Bonthuis, B., Jarvis, V., & Vanhala, J. (2016). Shifts in the euro area Beveridge curve and their determinants. *European Central Bank Economic Bulletin*, Issue 4/2016.
6. Elsby, M. W. L., Michaels, R., & Solon, G. (2009). The ins and outs of cyclical unemployment. *American Economic Journal: Macroeconomics*, 1(1), 84–110.
<https://doi.org/10.1257/mac.1.1.84>
7. European Central Bank. (2022). *Labour market developments in the euro area after the COVID-19 pandemic*. ECB Economic Bulletin, Issue 8/2022.
8. Eurostat. (2023). *Job vacancy statistics – quarterly data*. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Job_vacancy_statistics
- Hobijn, B., & Şahin, A. (2013). Beveridge curve shifts across countries since the Great Recession. *International Labour Review*, 152(3–4), 459–480.
<https://doi.org/10.1111/j.1564-913X.2013.00175.x>
9. Nickell, S., Nunziata, L., & Ochel, W. (2005). Unemployment in the OECD since the 1960s: What do we know? *The Economic Journal*, 115(500), 1–27.
<https://doi.org/10.1111/j.0013-0133.2005.00967.x>
10. OECD. (2023). *From symptoms to solutions: The structural roots of labour shortages*. OECD Publishing. Available at: <https://www.oecd.org/employment/from-symptoms-to-solutions-the-structural-roots-of-labour-shortages.htm>
11. Pissarides, C. A. (2000). *Equilibrium unemployment theory* (2nd ed.). Cambridge, MA: MIT Press.

ORGANIZATIONAL ADOPTION OF CAATTS IN INTERNAL AUDITING: A FACTOR IN STRENGTHENING RESILIENCE IN ENVIRONMENTAL TURBULENCE

Katarina Topolko Herceg

Faculty of Organization and Informatics, University of Zagreb

Pavlinska 2, 42000 Varaždin, Croatia

ktopolko@student.foi.hr

ABSTRACT

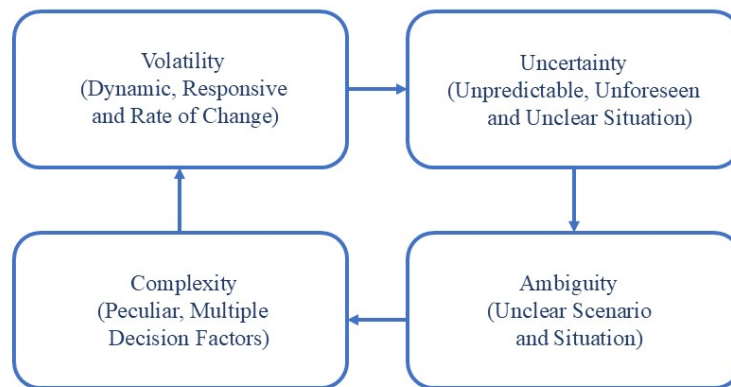
Environmental turbulence significantly reshapes the conditions under which internal auditing performs. Given the complexity and volatility of modern business environments, internal auditing approaches grounded in manual procedures are becoming insufficient. Computer-Assisted Audit Tools and Techniques (CAATTs) represent a technological enabler capable of enhancing internal auditing efficiency and analytical depth. This research was necessitated by the lack of a comprehensive theoretical framework that elucidates how CAATTs enable organizations to adapt to highly turbulent environments, thereby fostering organizational resilience. The objective of this research is to investigate how the organizational adoption of CAATTs in internal auditing impacts the organization's ability to navigate environmental turbulence. This research provides an overview of the theoretical framework that links the organizational adoption of technology in internal auditing to resilience in the context of environmental turbulence. The content analysis presented in this study examines contemporary publications spanning the years 2020 through 2025 to offer a novel perspective on the strategic role of CAATTs in bolstering resilience amidst environmental turbulence. Key findings indicate how the organizational adoption of CAATTs in internal auditing directly contributes to the overall resilience of the organization. The results also indicate a significant shift in recent scholarly discourse (2020–2025), emphasizing that the integration of CAATTs is no longer a choice but a necessity for maintaining organizational resilience in an increasingly turbulent environment. With regard to the analyzed literature, there is a need for further academic examination of the progress in the organizational adoption of technologies such as CAATTs in internal auditing in order to strengthen organizational resilience in the face of environmental turbulence.

Keywords: *Computer-Assisted Audit Tools and Techniques, environmental turbulence, internal auditing, organizational resilience, organizational technology adoption*

1. INTRODUCTION

The concept of a stable and predictable world is obsolete, even though numerous static organizations persist today. In a turbulent environment that includes crises, rapid digital changes and geopolitical risks, internal auditing must be agile and react quickly. Traditional auditing methodologies, grounded in sample-based testing and manual documentation, are inadequate in meeting expectations of turbulent environment. The turbulent environment generates a huge volume of data. Adopting Computer-Assisted Audit Tools and Techniques (CAATTs) allows internal auditors to process all data, not just samples, which drastically reduces risk. CAATTs enable continuous review instead of slow quarterly reviews. Rapid technological advancements, cyber threats and global market instability increase the need for continuous risk monitoring. Internal auditing today operates in an business environment characterized by volatility, uncertainty, complexity, and ambiguity (VUCA world). The concept of a VUCA world was first introduced by the U.S. military (Covarrubias Moreno, 2021). The term began to be used in the late 1980s and early 1990s to describe the turbulent, uncertain, and ambiguous global environment that emerged after the Cold War.

The term was later accepted in strategic management and business for describing rapid change in the 21st century. Volatility describes the rate of rapid change, characterizing the dynamic patterns observed within socio-environmental systems (Bujas et al., 2021). Uncertainty is characterized by a lack of predictability regarding outcomes and the heightened likelihood of unexpected events (Bujas et al., 2021). Complexity is defined as the intricate and extensive network structure and the dynamic pathways existing between the numerous components of a system (Bujas et al., 2021). Ambiguity is related to the obscurity of the true state of affairs, encompassing the potential for misinterpretation, the mixed meanings of operating conditions, and the potential for contradictory outcomes of actions (Bujas et al., 2021). Only organizations that successfully implemented timely transformations and maintained global competitiveness have proven resilient to the pressures of the VUCA world, while others have ceased to exist (Bujas et al., 2021). Figure 1. illustrates the concept of a VUCA world.



*Figure 1: VUCA Concept
(Source: Kumar et al., 2024.)*

In the described context, CAATTs have emerged as essential instruments in the modernization of auditing practices. CAATTs include a variety of software applications and digital methodologies that support data extraction, automated testing, continuous monitoring, fraud detection and predictive analytics. Organizational adoption of CAATTs in internal auditing can enhance efficiency, improve accuracy, and strengthen early-warning capabilities (Ahmi et al., 2014, Serpeninova et al., 2020, Smidt et al., 2019). The central thesis of this paper is that the organizational adoption of CAATTs in internal auditing is not merely a technological upgrade but a strategic necessity for enhancing organizational resilience in environmental turbulence. CAATTs contribute to internal auditing's dynamic capabilities by enabling real-time insights, automated transactions testing, and comprehensive analytics (Owino and Musuva, 2022). However, the effectiveness of this adoption depends heavily on technological infrastructure, organizational conditions, and environmental factors. The fundamental goal of this paper is to provide a theoretical foundation for understanding the connection between the organizational adoption of CAATTs in internal auditing and the achievement of organizational resilience under conditions of environmental turbulence. This research addresses the following research questions (RQ): RQ1. What pressures does internal auditing encounter during periods of environmental turbulence? RQ2. To what extent do the concepts of organizational resilience and organizational immunity diverge? RQ3. How do CAATTs serve as a strategic tool for strengthening organizational resilience in environmental turbulence?

The structure of the paper is as follows. Chapter 2 defines main theoretical concepts, Chapter 3 describes the methodology, Chapter 4 provides content analysis, and Chapter 5 concludes with theoretical implications and presents future directions.

2. THEORETICAL FOUNDATIONS

Environmental turbulence (ET) is defined by the rate, magnitude, and inherent unpredictability of changes occurring across an organization's internal and external operating environment (Arici and Gok, 2023). ET manifest through technological disruption, regulatory volatility, competitive dynamics, cyber threats, or organizational restructuring. Scholars typically decompose turbulence into several interrelated dimensions - technological turbulence, competition intensity and market turbulence (Arici and Gok, 2023, Ojha et al. 2021). *Technological turbulence (TT)* is the speed of technological progress in an organization coupled with the breadth and diversity of those technologies across the industry (Arici and Gok, 2023). TT is primarily driven by rapid digital innovation, including automation, artificial intelligence, data analytics, blockchain technologies, and critical cybersecurity challenges. These developments fundamentally reshape operational processes, risk profiles, and assurance needs within the organization. *Market turbulence (MT)* indicate competitive instability, fluctuating consumer behavior, and exposure to global economic shocks. MT is defined as the unpredictable rate of change and instability observed in the external environment, encompassing fluctuations in customer demands, shifting expectations, evolving market preferences, and advancements in product development and production technologies (Arici and Gok, 2023). *Competition intensity (CI)* is defined as the degree of rivalry present within a market, linked with the level of predictability regarding the competitive actions of market rivals (Arici and Gok, 2023). CI has the driving influence on MT and TT (Ojha et al. 2021). Such conditions necessitate that organizations develop the capability to anticipate risks and respond rapidly. ET thus constitutes a multidimensional phenomenon, requiring internal auditing functions to strategically develop agility, analytical sophistication, and advanced adaptive capacity. Resilience is the manner in which business organizations utilize their resources and capabilities to interact with the environment following an external shock. Resilience can also be defined as a measure of a system's stability and its capacity to absorb disruptions while maintaining existing relationships between system units following the occurrence of a shock (Damić, 2021). Organizational resilience is the organization's capacity to anticipate, prepare for, respond to, and effectively recuperate from significant disruptions, systemic crises, or substantial challenges (Georgescu et al., 2024). This capacity requires the seamless integration of core functions - specifically risk management, business continuity, and crisis management - to guarantee uninterrupted operational performance. The goal is to adapt to new circumstances and maintain business activities at a level consistent with the period preceding the shock (Damić, 2021). ET, characterized by rapid technological progress, regulatory volatility, cybersecurity threats, and organizational transformation, has altered the expectations placed upon internal auditing. In such dynamic conditions, organizational resilience has emerged as a critical organizational capability. One of the most significant enablers of organizational resilience is the adoption of CAATTs. CAATTs are computer software tools and associated techniques that enable auditors to process and analyze data from information systems, thereby facilitating the effective performance of audit procedures (Nasrah et al., 2023). CAATTs provide the technological support necessary for enhancing analytical depth, operational agility, and strategic foresight. Theoretical models used in research on organizational technology adoption are the Diffusion of innovation (DOI) theory, The Technology-organization-environment (TOE) framework, Institutional theory and The Iacovou et al. model. The DOI theory is a sociological theory that explains the process and patterns driving the successful adoption of new technology (Shahadat et al., 2023).

Diffusion occurs when innovative ideas, such as new technologies, are accepted and subsequently adopted across organizations, groups, individuals, or subsystems (Horani et al., 2023). This theory identifies five key technological attributes - trialability, observability, complexity, relative advantage, and compatibility - that are crucial for maximizing the successful adoption rate. In 1983, Paul DiMaggio and Walter Powell introduced the concept of institutional isomorphism - a convergence mechanism in which organizations operating within the same field gradually become more alike, driven by environmental constraints that compel them to adopt similar practices or models of behavior. This theoretical perspective underscores the powerful effect that the institutional context exerts on organization behavior, providing an essential framework through which the dynamics of organizational transformation can be analyzed (Sun et al., 2016). Within the institutional context, external pressures heavily condition the process of adopting innovations. Organizational decisions are therefore shaped by a wider set of societal and political influences, rather than exclusively by internal managerial objectives. The Iacovou et al. model anchors its findings on three primary contextual factors that exert influence over the successful implementation of information systems within organizations: perceived benefits, organizational readiness and external pressure (Iacovou et al., 1995). The central point is interplay between organizational aims and exogenous pressures (political and social). Consequently, technological decisions are shown to be influenced not only by rationality but also by underlying social and cultural elements. TOE framework specifically delineates three types of elements that critically influence the adoption of new technologies: technological context, organizational context and environmental context. *The technological context* encompasses both the necessary facilities and operations as well as relevant internal and external technologies that have the potential to enhance organizational productivity and performance (Tetteh et al., 2025). *The organizational context* encompasses the internal resources and inherent characteristics of the organization. This includes organizational attributes such as size, structure, and managerial hierarchy, as well as the nature and quality of human resources (employee skills and qualifications) (Tetteh et al., 2025). Furthermore, it covers the availability, characteristics, and quality of organizational technologies and financial resources crucial for technology adoption. *The environmental context* refers to the setting in which the organization operates and its external interactions (Tetteh et al., 2025). This includes the dynamics of the organization's industry, interactions with business partners and competitors, government entities, and external stakeholders. The strength of the TOE framework lies in its capacity to simultaneously integrate both internal and external factors into an unified paradigm of adoption (Nguyen et al., 2022). The TOE framework is predominantly used, given its versatility and extensive applicability. It enables researchers to investigate adoption choices by examining the interplay among technological competencies, organizational features, and environmental elements (Oliviera and Martins, 2011). In summation, organizational adoption of CAATs in internal auditing is demonstrably influenced by a multidimensional set of variables, encompassing elements from the technological, organizational, and the broader environmental context.

3. METHODOLOGY

The literature review was selected as the appropriate methodology, primarily owing to its inherent transparency and comprehensive nature. Literature reviews are essential for synthesizing the fragmented body of knowledge within a specific domain, thus offering a structured overview. The search was conducted in Scopus, ScienceDirect, IEEE Xplore, and Google Scholar. A set of keywords was identified for the purpose of ensuring comprehensive and efficient literature retrieval. The Boolean operators AND and OR were employed in the search strategy to enhance search precision.

These are, in order, (("CAATTs" OR "audit analytics" OR "digital auditing" OR "continuous auditing") AND ("internal audit" OR "internal auditing" OR "audit function") AND ("resilience" OR "dynamic capabilities" OR "environmental turbulence")). The inclusion criteria for the selection process were established as follows: (1) Studies must have been published between the years 2020 and 2025; (2) The primary focus of the paper needed to be on the organizational adoption of CAATTs, internal auditing, organizational resilience, and environmental turbulence; (3) Only peer-reviewed journal articles and review papers were accepted; and (4) Documents had to be accessible in either English or Croatian. Correspondingly, papers were excluded if they met any of the following criteria: (1) The study lacked empirical or theoretical contributions directly related to the research topic; (2) The focus was primarily on external auditing or the individual acceptance of CAATTs (rather than organizational adoption); (3) The document was identified as a duplicate; or (4) The full text was not accessible in either English or Croatian. The selection methodology encompassed the following phases: initial identification of relevant documents (930), subsequent elimination of duplicate entries (353), preliminary evaluation of titles and abstracts (116), comprehensive assessment of full texts (45), and ultimate final inclusion (19). The chosen papers were then subjected to qualitative analysis, primarily concentrating on content analysis. The content analysis in this research is strictly limited to literature published between 2020 and 2025, ensuring the currency of the findings.

4. CONTENT ANALYSIS

Addressing RQ1, it is evident that environmental turbulence significantly amplifies expectations placed on internal auditing, creating several critical pressures: (a) Demand for continuous auditing - traditional cyclical audits are insufficient in environments where risks evolve daily, necessitating continuous insight into control effectiveness (Liović, Barišić, 2024); (b) Increased risk complexity - complexity of technology introduces new categories of risk, including cybersecurity vulnerabilities, data integrity issues, automation bias, algorithmic risks, and sophisticated digital fraud schemes (Durst et al., 2024); (c) Heightened accountability and transparency - regulators and governance bodies demand more rigorous testing and enhanced documentation (Pimenova et al., 2023); (d) Pressure for strategic foresight - internal auditing is increasingly expected to transition beyond merely evaluating controls to providing strategic foresight and advisory value to the organization (Haarhaus and Liening, 2020); (e) Operational pressure - shorter audit cycles, the necessity for more complex testing, and increased reporting requirements place significant strain on internal auditing resources and capacity (Joshi, 2021). These cumulative pressures underscore the fundamental need for technological augmentation of internal auditing processes to effectively maintain internal auditing quality under turbulent conditions. Organizational resilience is primarily observed through their adaptability to evolving market circumstances (Gao et al., 2025). Resilient organizations strive for continuous adaptation to prevent external disruptions from negatively impacting core organizational stability (Gao et al., 2025). Resilience enables organizations to mitigate the damaging effects of interruptions, thereby actively limiting potential financial losses, reputational harm, or extensive operational downtime. By purposefully establishing resilience frameworks (Carlos and Tan, 2021), organizations are better positioned to sustain stability, protect their employees, and ensure the continuous delivery of goods or services to their customers. An organization's resilience maturity can be reliably assessed through various systematic methodologies. These methods encompass conducting comprehensive risk assessments, detailed business impact analyses, simulation exercises, etc (Stocker et al., 2022). These evaluations are vital for identifying intrinsic weaknesses, measuring the efficacy of established plans and procedures, and determining specific domains requiring strategic enhancement.

Consistent monitoring and rigorous evaluation are essential components that ensure resilience strategies remain current, significant, and appropriately aligned with evolving internal and external threat landscapes (Singh and Best, 2023). Resilience in the context of internal auditing is the organization's ability to maintain operational continuity, uphold assurance quality, and adapt its methods in response to disruptions (Lampropoulos et al., 2025). Internal auditing contributes to by anticipating disruptions, absorbing shocks, maintaining performance under pressure, and adapting its methodologies in response to environmental turbulence. As internal auditing increasingly faces heightened environmental turbulence, CAATTs can contribute significantly to its resilience (Alnatour et al., 2024) - the ability to withstand disruptions, and rapidly recover to ensure sustained effectiveness. Organizational immunity is an indicator of an organization's resilience to intensive and rapid changes in its turbulent environment. Organizations with strong immunity can adapt quickly to changes and overcome them with minimal consequences. Constantly strengthening organizational immunity is important for the long-term survival of an organization (Jabr and Mahmoud, 2022). Immunity enhances organizational ability to resist potential risks and threats (Al-Yaari and Al-Manzuo, 2025). Organizational resilience is a broader and more proactive concept. It encompasses the entire cycle of dealing with a crisis or shock, from anticipation to recovery. Organizational immunity is a narrower and more reactive concept. The focus is on internal protection against specific threats. Table 1 shows comparison of the terms organizational immunity and organizational resilience.

	Organizational Immunity	Organizational Resilience
Focus	Mechanisms within a system that actively neutralize or prevent a threat or risk from entering the organization.	Anticipation, prevention, response, recovery, and transformation after a crisis or shock.
Approach	Structural and defensive. Consists of controls, rules, and processes set up to ensure the integrity (health) of the organization.	Dynamic and adaptive. The goal is not just to return to the previous state (recovery), but to adapt and improve (build back better).
Time	Immediate or Short-term. Applied before and during an attempt to violate integrity.	Long-term. Applied before, during, and after a shock.

Table 1: Comparison of Organizational Immunity and Organizational Resilience (Source: Author)

The synthesis of findings for RQ2 leads to the conclusion that the main difference is that organizational immunity refers to the ability of a system's capacity to maintain its integrity by repelling or eliminating known internal threats (a fundamental prerequisite for achieving overall resilience), and organizational resilience refers to the ability of an organization to survive an unknown, massive environmental shock (that immunity could not prevent) and to restructure, adapt, and continue to function. The evidence compiled to address RQ3 demonstrates that CAATTs strengthen organizational resilience in several ways. First, they enhance analytical capability by enabling internal auditors to process, analyze, and interpret large datasets with greater accuracy and speed (Alnatour et al., 2024). Advanced internal audit analytics, anomaly detection algorithms, and full-population testing significantly enhance the internal auditors' ability to recognize intricate patterns and emerging risks that would otherwise remain hidden within conventional sample-based audits (Betti et al., 2021; Huang et al., 2022). This analytical augmentation increases internal auditing's capacity to anticipate disruptions, consequently strengthening its anticipatory resilience. Second, CAATTs facilitate real-time risk monitoring, a crucial capability in volatile and complex environments (Onyenahazi, 2025).

Continuous auditing and automated control testing enable internal auditors to promptly detect control weaknesses, thereby facilitating timely corrective actions and mitigating the potential impact of disruptive events (Eulerich et al., 2020). In this capacity, CAATTs support both the absorptive and reactive dimensions of organizational resilience by providing early-warning signals and allowing for rapid intervention (Al Natour et al., 2024). Third, CAATTs support organisational resilience by enabling internal auditing methodologies to be promptly adjusted in alignment with emerging risks and evolving business conditions (Onyenum, 2024). This is achieved through automated workflows and integration with enterprise systems, allowing auditors to re-scope audit plans, introduce new tests, or reallocate audit resources with minimal delay. This degree of flexibility is essential for sustaining the relevance of internal auditing during periods of significant organizational transformation, such as mergers, restructurings, or crisis-driven operational shifts. Fourth, CAATTs strengthen business continuity (Al Natour et al., 2024). Cloud-based audit platforms, robust document management systems, and remote auditing capabilities empower internal auditing to remain fully functional even when traditional on-site audits are infeasible. The ability to sustain uninterrupted operations represents a basis of resilient audit performance. Finally, CAATTs contribute to resilience by supporting evidence-based decision-making. Data visualization tools, automated dashboards, and predictive models provide internal auditors with sophisticated insights that raise the quality of recommendations provided to management and audit committees (Ilori et al., 2022). As the internal auditing increasingly assumes an advisory role, the capacity to deliver forward-looking, analytically grounded insights is required for achieving long-term resilience and maximizing strategic value.

5. CONCLUSION

In the face of environmental turbulence, traditional internal auditing methodologies exhibit several limitations: manual testing is slow and error-prone, sample-based testing lacks comprehensiveness, static audit plans cannot adjust quickly to emerging risks, there is limited capacity to perform predictive or anomaly analytics, and weak connectivity with business systems reduces transparency. Consequently, internal auditing that relies heavily on traditional approaches risks decreased accuracy, relevance, and the inability to detect complex fraud patterns in large datasets. The role of internal auditing extends beyond mere control; it serves as a key line of defense and advisor in managing risks under turbulent conditions. Traditional auditing methods, however, which are typically based on sampling, often fail to keep pace with the rapidly changing speed of markets. Consequently, organizational adoption of CAATTs in internal auditing is positioned as a necessary technological response to this environmental turbulence. The organizational adoption of CAATTs strengthens organizational resilience by enhancing analytical sophistication, enabling real-time risk monitoring, increasing operational agility, and supporting continuity under disruptive conditions. However, the extent to which CAATTs contribute to organisational resilience depends on a range of factors, such as technological infrastructure, internal auditor competencies, leadership support, environmental pressures, among others. When these conditions are present, CAATTs serve not merely as technological tools but as mechanisms for transforming internal auditing into a resilient, adaptive, and strategically relevant function: capable of navigating the complexities of modern organizational environments. The research in this area has not received the required attention. Consequently, there remains a significant gap in the literature regarding a theoretical and empirical understanding of organizational adoption of CAATTs in internal auditing in the context of organizational resilience in environmental turbulence. This deficit limits the practical applicability of current findings. Therefore, substantial scholarly inquiries are warranted to fully address the complexities inherent in this domain and provide conclusive findings for the management of organizations.

Regarding research limitations, the usage of specific search terms, Boolean operators, and selected databases may have unintentionally excluded relevant studies that were published in lesser-known databases or used a different vocabulary. The qualitative analysis inherently involves researcher interpretation, which may be subjective. Studies utilized diverse methodologies, samples, and measurement scales, which makes it challenging to draw a firm, unified conclusion. While this review includes examples, it fails to provide a thorough analysis of the data and corresponding methodologies. This body of knowledge provides a foundation for future research. Additional empirical studies are warranted to comprehensively evaluate the long-term impact of organizational adoption of CAATTs on strengthening internal auditing resilience within environmental turbulence. It would be valuable to explore how do the competencies of internal auditors moderate the relationship between the adoption of CAATTs and the improvement of organizational resilience. Future research should explore the specific mechanisms through which organizational adoption of CAATTs bolsters internal audit functions under environmental pressure. A promising direction for future research are longitudinal case studies that follow audit functions through significant organizational changes (such as mergers or major crises) to assess how CAATTs maintain internal auditing continuity.

LITERATURE:

1. Ahmi, A., Saidin, S. and Abdullah, A. (2014). IT Adoption by Internal Auditors in Public Sector: A Conceptual Study. *Procedia - Social and Behavioral Sciences*, 164, pp. 591–599, <https://doi.org/10.1016/j.sbspro.2014.11.151>.
2. Al-Yaari, A.D.M. and Al-Manzuoa, Z.A.A. (2025). The Role of Organizational Immunity in Organizational Agility in Yemeni Investment Institutions in the Water Sector (A Field Study in the Capital, Sana'a, Yemen). *International Journal of Environmental Sciences*, 11(11s), 647. <https://theaspd.com/index.php>
3. Al Natour, A.R., Zaidan, H., Said, Y.H.Z. and Al-Mawali, H. (2024). The Role of Forensic Accounting Skills and CAATTs Application in Enhancing Firm's Cyber Resilience. In *2024 2nd International Conference on Cyber Resilience (ICCR)*. pp. 1–5. <https://doi.org/10.1109/ICCR61006.2024.10532901>
4. Arici, T., and Gok, M. S. (2023). Examining Environmental Turbulence Intensity: A Strategic Agility and Innovativeness Approach on Firm Performance in Environmental Turbulence Situations. *Sustainability*, 15(6), 5364. <https://doi.org/10.3390/su15065364>
5. Betti, N., Sarens, G., Poncin, I. (2021) Effects of digitalisation of organisations on internal audit activities and practices. *Managerial Auditing Journal*, 36(6), 872–888. <https://doi.org/10.1108/MAJ-08-2020-2792>
6. Bujas, V., Schröckenfuchs, M., Kličko, N., Braš, M., Badovinac, S. and Čabo Aras, J. (2021). The Power of Transformation and the Leadership Supporting It - Including Mental Health Perspective. *Psychiatria Danubina*, 33(Suppl 4), pp. 686-690. PMID: 34718303.
7. Carlos, C.N.M. and Tan, E.B. (2021). Resilience: A necessity to manage change in organizations. *International Journal of Research Studies in Education*, 10(8), pp. 1-6, <https://doi.org/10.5861/ijrse.2021.608>
8. Covarrubias Moreno, O.M. (2021). Coordinated governance in the VUCA scenario. *Hrvatska i komparativna javna uprava*, 21(3), pp. 393-422. <https://doi.org/10.31297/hkju.21.3.6>
9. Damić, M. (2021). Organizational resistance and quality management. In *Proceedings of the 22nd International Symposium on Quality "Quality – yesterday, today, tomorrow"*. Zagreb: Croatian quality managers society, pp. 275-289. <https://doi.org/10.52730/ULGD8374>
10. DiMaggio, P. J. and Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, 48(2), pp. 147–160.
11. Durst, S., Hinteregger, C. and Zieba, M. (2024). The effect of environmental turbulence on cyber security risk management and organizational resilience. *Computers & Security*, 137, 103591. <https://doi.org/10.1016/j.cose.2023.103591>

12. Gao, X., Jaggi, J., Yan, H. (2025). Internal auditors and crisis management: a post-crisis outcome evaluation. *Journal of Accounting & Organizational Change*, 21(4), pp. 692–710, <https://doi.org/10.1108/JAOC-03-2024-0110>
13. Georgescu, I., Bocean, C.G., Vărzaru, A.A., Rotea, C.C., Mangra, M.G. and Mangra, G.I. (2024). Enhancing Organizational Resilience: The Transformative Influence of Strategic Human Resource Management Practices and Organizational Culture. *Sustainability*, 16(10), 4315. <https://doi.org/10.3390/su16104315>
14. Haarhaus, T. and Liening, A. (2020). Building dynamic capabilities to cope with environmental uncertainty: The role of strategic foresight. *Technological Forecasting and Social Change*, 155, 120033. <https://doi.org/10.1016/j.techfore.2020.120033>
15. Horani, O., Al-Adwan, A., Yaseen, H., Hmoud, H., Al-Rahmi, W. and Alkhalifah, A. (2023). The critical determinants impacting artificial intelligence adoption at the organizational level. *Information Development*, 41(3), pp. 1055-1079. <https://doi.org/10.1177/02666669231166889>
16. Huang, F., No, W.G., Vasarhelyi, M.A. and Yan, Z. (2022). Audit data analytics, machine learning, and full population testing. *The Journal of Finance and Data Science*, 8, pp. 138-144. <https://doi.org/10.1016/j.jfds.2022.05.002>
17. Eulerich, M., Georgi, C., and Schmidt, A. (2020). Continuous Auditing and Risk-Based Audit Planning - An Empirical Analysis. *Journal of Emerging Technologies in Accounting*, 17(2), pp. 141–155. <https://doi.org/10.2308/JETA-2020-004>
18. Iacovou, C.L., Benbassat, I. and Dexter, A.S. (1995). Electronic data interchange and small organizations: Adoption and impact of technology. *MIS Quarterly*, 19(4), pp. 465-485. <https://doi.org/10.2307/249629>
19. Ilori, O., Lawal, C., Friday, S., Isibor, N., and Chukwuma-Eke, E. (2022). The Role of Data Visualization and Forensic Technology in Enhancing Audit Effectiveness: A Research Synthesis. *Journal of Frontiers in Multidisciplinary Research*, 3(1), pp. 188-200. <https://doi.org/10.54660/IJFMR.2022.3.1.188-200>
20. Jabr, Z. K. and Mahmoud, B.I. (2022). Organizational immunity and its role in achieving strategic success: applied research at the general company for Iraqi airways, *International Journal of Transformations in Business Management*, 12(2), pp. 243–261, <http://doi.org/10.37648/ijtbm.v12i02.012>
21. Joshi, P.L. (2021). A Review of Agile Internal Auditing: Retrospective and Prospective. *International Journal of Smart Business and Technology*, 9(2), pp. 13-32. <http://doi.org/10.21742/ijstb.2021.9.2.02>
22. Kumar, A., Anand, G. and Nandedkar, T. (2024). A Smart Leader in VUCA World: Presenting Key Components of Strategic Leadership Using SLR Method. *Indonesian Management and Accounting Research*, 23(1), pp. 87-108. <https://doi.org/10.25105/imar.v23i1.18803>
23. Lampropoulos, S.D., Thanasas, G.L., Garefalakis, A. and Passas, I. (2025). Harmonizing Sustainability and Resilience: The Integral Role of Internal Audit in ESG Implementation - A Review. *International Journal of Financial Studies*, 13(4), 194. <https://doi.org/10.3390/ijfs13040194>
24. Liović, K. and Barišić, I. (2024). Digital Transformation of the Internal Audit Function – Analysis of Technology Acceptance Factors and Perspectives of Future Development, In *ERAZ Conference – Knowledge Based Sustainable Development: Vol 10. Conference Proceedings*. Lisbon: Association of Economists and Managers of the Balkans, pp. 147–156. <https://doi.org/10.31410/eraz.2024.147>
25. Nasrah, H., Muda, I. and Kesuma, S. (2023). Computer Assisted Audit Tools and Techniques Adoption: A Systematic Literature Review. *International Journal of Social Service and Research*, 3, pp. 630-638. <https://doi.org/10.46799/ijssr.v3i3.301>
26. Nguyen, T.H., Le, X. and Vu, T. (2022). An Extended Technology-Organization-Environment (TOE) Framework for Online Retailing Utilization in Digital Transformation: Empirical Evidence from Vietnam. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), 200. <https://doi.org/10.3390/joitmc8040200>

27. Ojha, D., Struckell, E., Acharya, C. and Patel, P.C. (2021). Managing environmental turbulence through innovation speed and operational flexibility in B2B service organizations. *Journal of Business & Industrial Marketing*, 36(9), pp. 1627-1645. <https://doi.org/10.1108/JBIM-01-2020-0026>
28. Oliveira, T. and Martins, M.R. (2011). Literature Review of Information Technology Adoption Models at Firm Level. *The Electronic Journal Information Systems Evaluation*, 14(1), pp. 110–121.
29. Onyenahazi, O.B. (2025). Integrating Artificial Intelligence in Financial Auditing to Enhance Accuracy, Efficiency, and Regulatory Compliance Outcomes. *International Journal of Research Publication and Reviews*, 2(7), pp. 23-44. <https://doi.org/10.55248/gengpi.6.0725.2402>.
30. Onyenum, R.U. (2024). Enhancing Internal Audit Efficiency for Effective Risk Management and Corporate Governance Frameworks. *International Journal of Research Publication and Reviews*, 5(12), pp. 3646-3659. <https://doi.org/10.55248/gengpi.5.1224.250122>.
31. Owino, B., and Musuva, P. (2022). Empirical Assessment of Improved Audit Quality Factors Using Computer-Assisted Audit Tools and Techniques (Caatts). *Journal of Language, Technology & Entrepreneurship in Africa*, 12(2), pp. 147–171. <https://doi.org/10.4314/jolte.v12i2>.
32. Pimenowa, O., Pimenov, S., Fyliuk, H., Sitnicki, M.W., Kolosha, V. and Kurinskyi, D. (2023). Sustainable Business Model of Modern Enterprises in Conditions of Uncertainty and Turbulence. *Sustainability*, 15(3), 2654. <https://doi.org/10.3390/su15032654>
33. Serpeninova, Y., Makarenko, S. and Litvinova, M. (2020). Computer-assisted audit techniques: classification and implementation by auditor. *Public Policy and Accounting*, 1(1), pp. 44–49. [https://doi.org/10.26642/ppa-2020-1\(1\)-44-49](https://doi.org/10.26642/ppa-2020-1(1)-44-49)
34. Shahadat, M.M., Nekomahmud, A., Ebrahimi, P. and Fekete Farkas, M. (2023). Digital Technology Adoption in SMEs: What Technological, Environmental and Organizational Factors Influence in Emerging Countries?. *Global Business Review*. <https://doi.org/10.1177/09721509221137199>
35. Singh, K. and Best, P. (2023). Auditing during a pandemic – can continuous controls monitoring (CCM) address challenges facing internal audit departments?, *Pacific Accounting Review*, 35(5), pp. 727–745. <https://doi.org/10.1108/PAR-07-2022-0103>
36. Smidt, L., Van der Nest, D.P., Steenkamp, L., Lubbe, D.S. and Ahmi, A. (2019). An Assessment of the Purpose of the use of Generalised Audit Software: A perspective of Internal Audit Functions in Australia. In *Proceedings of the 2019 14th Iberian Conference on Information Systems and Technologies (CISTI)*, Coimbra, Portugal, pp. 1–6, <https://doi.org/10.23919/CISTI.2019.8760882>.
37. Sun, S., Cegielski, C., Jia, A. and Hall, D. (2016). Understanding the Factors Affecting the Organizational Adoption of Big Data. *Journal of Computer Information Systems*, 58(3), pp. 193-203. <https://doi.org/10.1080/08874417.2016.1222891>
38. Stocker, J., Herda, N., Wolf, M. and Ruf, S. (2022). A Maturity Model to Assess and Foster the Resilience of Organizations. *Art and Society*, 1(3). Paradigm Academic Press. <https://doi.org/10.56397/AS.2022.12.01>
39. Tetteh, L.A., Simpson, S.N.Y., Nyabey, E.P., Kubaje, T.A., Togormey, R. and Tagoe, F. (2025). Utilising the technology - organisation - environment framework in understanding the adoption and usage of computer-assisted audit tools and techniques: a qualitative insight. *VINE Journal of Information and Knowledge Management Systems*, <https://doi.org/10.1108/VJKMS-01-2024-0015>.

FINANCIAL INDICATORS AND AVERAGE NET WAGES IN SELECTED INDUSTRIES OF THE CROATIAN ECONOMY

Maja Buljat

*University of Applied Sciences "Baltazar" Zaprëšić 10290, Zaprëšić, Croatia,
mbuljat@bak.hr*

Covic Kristijan

*University of Applied Sciences "Baltazar" Zaprëšić 10290, Zaprëšić, Croatia,
kcovic@bak.hr*

Doris Romic

*University of Applied Sciences "Baltazar" Zaprëšić 10290, Zaprëšić, Croatia,
doris.stanesic@bak.hr*

ABSTRACT

This study investigates the relationship between financial indicators and average net wages in selected industries of the Croatian economy, namely construction, trade, accommodation and food service activities, and financial and insurance activities. The research is based on secondary data from the Croatian Financial Agency (FINA) for the period from 2016 to 2023. It applies descriptive statistics, one-way analysis of variance (ANOVA), trend analysis, and Pearson correlation methods. The results indicate significant differences in wage levels across various industries. The financial sector consistently records the highest average net wages, while the accommodation and food service sector reports the lowest. In the construction, trade, and hospitality industries, higher liquidity and return on equity (ROE) are positively associated with higher wage levels, while indebtedness shows a negative correlation. In contrast, within the financial and insurance sector, efficiency is the only financial indicator that demonstrates a statistically significant relationship with wage levels. These findings suggest that sector-specific financial structures and performance metrics influence wage-setting policies differently. The study underscores the need for tailored wage policies that reflect the financial characteristics of each industry. While the findings are relevant for shaping strategic decisions in human resources and financial management, the research is limited by its correlational nature, and the scope is restricted to four industries. Future research should incorporate a broader range of sectors and adopt more advanced methodologies to examine causal relationships. Overall, the study provides valuable insights for policymakers and business leaders aiming to align wage systems with financial health and sector-specific conditions.

Keywords: *efficiency, financial indicators, industries, liquidity, wages*

1. INTRODUCTION

Wage levels are a central issue in modern economics. They are not only a fundamental source of income for individuals but also reflect broader dynamics of productivity, labor market performance, and macroeconomic stability. At the firm level, wages influence employee motivation, job satisfaction, and retention. At the national level, they shape household purchasing power, social welfare, and the balance between business performance, market conditions, and regulatory frameworks. For these reasons, understanding what determines wage levels is essential for both economic policy and corporate strategy. Financial indicators such as liquidity, indebtedness, efficiency, and return on equity (ROE) are commonly used to assess business performance and financial health. However, their role in shaping wage outcomes remains relatively underexplored, particularly in the context of specific economic sectors.

Different industries operate under distinct financial structures, business models, and risk environments, which likely influence how companies design and implement compensation policies. This study aims to examine the relationship between financial performance and wage levels across selected industries in the Croatian economy. It focuses on four sectors: construction; wholesale and retail trade, including motor vehicle repair; accommodation and food services; and financial and insurance activities. These industries were chosen because they differ in terms of capital intensity, operational structure, and labor market characteristics, all of which may affect how financial resources are allocated to wages. The main objective is to identify whether, and to what extent, financial indicators are associated with differences in average net wages across sectors. The analysis is based on the assumption, grounded in efficiency wage theory, that companies with stronger financial standing are more likely to offer higher wages. Research tasks include analyzing wage and financial data descriptively, testing wage differences between industries, examining trends over time, and assessing industry-specific correlations between financial indicators and wage levels. The study relies on quantitative methods and secondary data from the Croatian Financial Agency (FINA) covering the period from 2016 to 2023. Financial indicators are calculated using standard formulas based on company financial statements. The analytical framework includes descriptive statistics, one-way ANOVA with Tukey's post-hoc tests, dynamic trend analysis, and Pearson correlation analysis for each industry. Statistical processing and visualization were conducted using Stata software. Several limitations should be acknowledged. As the study is based on correlation analysis, it cannot establish causality. Also, the focus on only four industries limits the generalizability of the results to the entire economy. The paper is structured as follows. After the introduction, the second section reviews the relevant literature. The third section presents the research methodology, followed by a detailed presentation of results. The fifth section presents the findings, and the final section draws conclusions and outlines practical implications. This structure provides a comprehensive view of how financial characteristics influence wage outcomes across different sectors and offers useful insights for both policymakers and business leaders.

2. LITERATURE REVIEW

The relationship between corporate financial indicators and employee wage levels is a topic of considerable interest in economic science, both from theoretical and empirical perspectives. Understanding this connection is crucial for developing effective human resource management strategies, particularly in times of economic transition and amid pronounced sectoral differences in firms' financial structures. The theoretical literature often begins with the efficiency wage hypothesis. According to the model by Shapiro and Stiglitz (1984), employers pay wages above the market equilibrium to motivate workers, reduce turnover and enhance productivity. Akerlof and Yellen (1990) further stress the role of perceived fairness in compensation, which impacts employee loyalty and engagement. A similar effect is illustrated by the historical example of Ford's wage policy, which led to increased productivity and greater workforce stability (Raff and Summers, 1987). Empirical studies also confirm that financial indicators, especially liquidity and profitability, strongly influence wage-setting practices. Durrah, Rahman and Jamil (2016) find that higher liquidity enables firms to allocate more resources to wages, while Eljelly (2004) cautions that excessive liquidity without efficient capital management may constrain long-term wage growth. In the UK context, Blundell et al. (2013) highlight a weakening link between productivity and wages, pointing to minimal profit-sharing among firms. Debt levels are also recognized as a limiting factor in wage policy. Dadebo and Afolabi (2020), using a sample of Nigerian firms, demonstrate that high indebtedness reduces the capacity to offer competitive compensation. Interestingly, Micheli and Calce (2019) note that while capital structure does not directly determine firm performance,

maintaining a balanced structure can contribute to long-term stability, including consistent wage payments. The financial sector is marked by the specific importance of operational efficiency. McNulty and Brady (2022) show that banks and insurance companies, in their efforts to retain skilled professionals, design compensation systems that rely more on operational indicators such as the cost-to-income ratio than on traditional profitability metrics like return on equity (ROE). Ouimet and Simintzi (2015), through an analysis of firms during and after the 2008 financial crisis, confirm that stable and predictable wage systems enhance corporate resilience in times of crisis. Their findings suggest that companies paying higher wages, often reflecting stronger financial health, were more resistant to negative shocks, indicating a potential positive correlation between profitability and wage levels. Recent research further deepens the understanding of this relationship. Ratajczak et al. (2024) underscore the importance of a stable relationship between profitability and liquidity for sustaining viable wage systems, particularly in post-crisis contexts. Valeyre et al. (2016) show that a higher wage share in total expenditures is positively correlated with stock market performance, while Oliveira (2024) points out that high indebtedness negatively affects employee consumption, indirectly implying lower wage levels. In conclusion, the literature confirms a strong and multi-dimensional connection between financial indicators and wage levels, with significant sectoral variation. While liquidity and profitability are key wage determinants in the real sector, operational efficiency plays a dominant role in financial services. These insights form a solid basis for empirical analysis of the Croatian economy.

3. METHODOLOGY

The main objective of this study is to identify whether there are statistically significant differences in average net wages across selected industries of the Croatian economy and to examine the relationship between key financial indicators and wage levels within those sectors. The analysis is based on secondary data sourced from the publicly available financial statements submitted by companies to the Croatian Financial Agency (FINA), covering the period from 2016 to 2023. The research focuses on four industries, classified according to the National Classification of Activities (NKD): Construction (Section F), Wholesale and retail trade; repair of motor vehicles and motorcycles (Section G), Accommodation and food service activities (Section I) and Financial and insurance activities (Section K). Data were extracted from annual consolidated financial statements, which include balance sheets, profit and loss accounts, and additional financial disclosures. Only companies that operated continuously throughout the observed period and submitted complete annual reports were included in the analysis. The dataset was cleaned using interquartile range rules to remove extreme outliers, and firms with negative equity or extremely distorted financial metrics were excluded to ensure representativeness and data quality. The final sample includes a total of X companies, distributed across the four industries (exact numbers to be specified).

The following financial indicators were used as independent variables:

- **Liquidity**, defined as the ratio of current assets to short-term liabilities:
 $Liquidity = \text{Current Assets} / \text{Short-Term Liabilities}$
- **Indebtedness**, defined as the ratio of total liabilities to total assets:
 $Indebtedness = \text{Total Liabilities} / \text{Total Assets}$
- **Efficiency**, calculated as the ratio of total revenues to total expenses:
 $Efficiency = \text{Total Revenues} / \text{Total Expenses}$
- **Return on Equity (ROE)**, defined as the ratio of net profit to total equity:
 $ROE = \text{Net Profit} / \text{Total Equity}$

The primary dependent variable was the average net wage per employee, derived from income statement data and accompanying notes in the financial reports.

The analytical framework of the study consists of the following methods: descriptive statistics , One-way analysis of variance (ANOVA), Tukey’s HSD post-hoc test to identify specific industry pairs where statistically significant differences exist and Dynamic trend analysis to observe changes in wages and financial indicators over the 2016–2023 period. All statistical analyses and data visualizations were conducted using Stata software, version 17.0. All calculations, figures, and tests were performed by the authors. The code used in the analysis is available upon request to editors or reviewers to ensure transparency and reproducibility. As the study relies on correlation-based methods, it does not allow for causal inference. Nevertheless, the patterns identified may serve as a solid foundation for the development of future hypotheses and more advanced analytical models, such as panel regressions or structural equation modeling. The financial data used in this research are publicly available from FINA but may be subject to access restrictions and associated costs. If required, the authors can provide additional information on the data extraction and processing methodology.

4. EMPIRICAL RESULTS AND DISCUSSION

The research findings are presented across several analytical levels to provide insights into the financial structure and differences in average net wages among industries. First, a descriptive analysis was conducted to provide a basic overview of key indicators by industry. This was followed by a one-way analysis of variance (ANOVA) and post-hoc tests used to identify statistically significant differences in wage levels. A dynamic trend analysis allowed for an examination of changes over time, while the correlation analysis explored in more detail the relationships between financial indicators and wage levels within each industry.

4.1. Descriptive Analysis by Industry

To gain insight into the financial indicators and average net wages within the observed industries, a descriptive analysis was carried out, including the calculation of basic statistical measures. This analysis allows for comparison of variables between industries and the identification of potential patterns in the data. The financial indicators included in the analysis are: liquidity, indebtedness, efficiency, and return on equity (ROE), with average net wage serving as the key variable of interest. Mean values (M) and standard deviations (SD) were used to present central tendency and data dispersion within each industry. Table 1 presents the mean values and standard deviations of financial indicators and average net wages across the four observed industries: Construction, Wholesale and retail trade; repair of motor vehicles and motorcycles, Accommodation and food service activities and Financial and insurance activities

Industry	Liquidity (M ± SD)	Indebtedness (M ± SD)	Efficiency (M ± SD)	ROE (M ± SD)	Average Net Salary (EUR) (M ± SD)
Construction	1.07 ± 0.15	0.52 ± 0.02	0.96 ± 0.02	0.05 ± 0.02	712.13 ± 99.05
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	1.28 ± 0.13	0.64 ± 0.05	0.96 ± 0.01	0.19 ± 0.02	788.63 ± 122.85
Accommodation and Food Service Activities	0.80 ± 0.15	0.55 ± 0.02	0.96 ± 0.10	0.08 ± 0.03	691.77 ± 111.45
Financial and Insurance Activities	1.29 ± 0.58	0.74 ± 0.34	0.96 ± 0.16	0.08 ± 0.06	1,015.16 ± 153.93

*Table 1: Descriptive statistics of financial indicators and average net salary by industry
Source: FINA data; author’s calculation*

The data analyzed in Table 1 reveal pronounced differences in the levels of financial indicators and average net wages across the observed industries.

The highest average net wage was recorded in Financial and insurance activities (M = 1,015.16 EUR; SD = 153.93 EUR), indicating that this industry offers significantly more favorable working conditions compared to others. Conversely, the lowest average net wage was found in Accommodation and food service activities (M = 691.77 EUR; SD = 111.45 EUR), which may be the result of structural limitations, productivity differences, or business models specific to this sector. Liquidity was highest in the Financial and insurance activities sector (M = 1.29; SD = 0.58), suggesting a relatively strong ability to meet short-term obligations. On the other hand, the lowest liquidity was observed in Accommodation and food service activities (M = 0.80; SD = 0.15), which may indicate increased financial risk. The return on equity (ROE) reached its highest value in Wholesale and retail trade; repair of motor vehicles and motorcycles (M = 0.19; SD = 0.02), implying more efficient resource management in this sector. Indebtedness showed moderate variation across industries, with the highest average level found in Financial and insurance activities (M = 0.74; SD = 0.34). These results highlight the heterogeneity of financial structures between industries and provide a solid foundation for further analysis of the relationships between financial indicators and wage levels in the following chapters.

4.2. Analysis of variance and post-hoc testing of differences in average net wages

To determine whether statistically significant differences in average net wages exist among the different industries, a one-way analysis of variance (ANOVA) was conducted. This method enables testing whether there is a statistically relevant difference between the means of multiple groups, where average net wage is defined as the dependent variable, and industry as the independent variable with four levels (Construction; Wholesale and retail trade including motor vehicle repair; Accommodation and food service activities; Financial and insurance activities). The following hypotheses were formulated:

- Null hypothesis (H_0): There are no significant differences in average net wages among industries.
- Alternative hypothesis (H_1): At least one industry exhibits a statistically significant difference in average net wage compared to the others.

The results of the ANOVA test (Table 2) indicated that there is a statistically significant difference in average net wages across industries ($F(3,28) = 11.51$; $p < 0.001$). The obtained F-value suggests that the variability between groups significantly exceeds the variability within groups, which allows for the rejection of the null hypothesis and confirms the pronounced heterogeneity of the observed industries in terms of wage levels.

Source	SS	df	MS	F	p
Industry	526,750.83	3	175,583.61	11.51	<0.001
Residual	427,138.27	28	15,254.94		
Total	953,889.11	31			

Table 2: ANOVA analysis of the impact of industry on average net wage
Source: author's calculation

Table 2 presents the results of the one-way ANOVA analysis. The obtained F-value of 11.51, with a p-value of less than 0.001, clearly confirms the existence of statistically significant differences in average net wages among the observed industries. These results indicate that the industry has a significant impact on employee wage levels. The variability between groups (industries) is substantially greater than the variability within groups, which justifies the implementation of further analyses to precisely identify where these differences lie.

The distribution of average net wages by industry is illustrated in the boxplot (Figure 1), which clearly shows that Financial and insurance activities exhibit a higher median and a wider interquartile range compared to the other industries. This visual representation further supports the ANOVA findings and emphasizes the distinctive nature of this sector in terms of employee compensation.

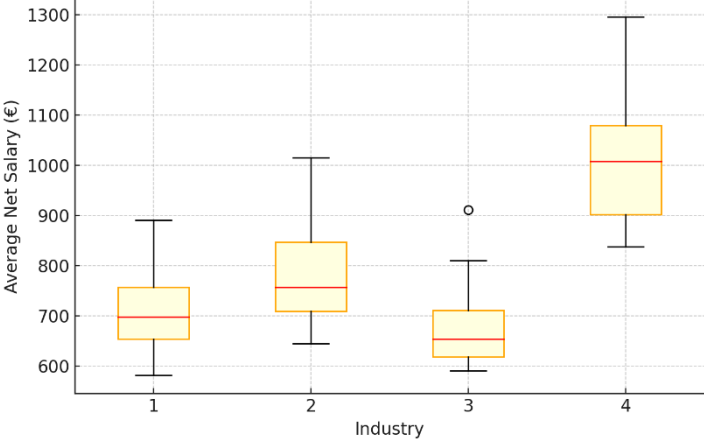


Figure 1: Boxplot of average net wages by industry
Source: author’s calculation

Figure 1 graphically illustrates the distribution of average net wages across the four analyzed industries. Financial and insurance activities stand out with a higher median and a wider interquartile range compared to other sectors. This distribution suggests both unique compensation patterns in this industry and greater wage heterogeneity within the sector itself. In contrast, Construction and Accommodation and food service activities exhibit narrower ranges and lower medians, which may indicate more stable, yet lower wage levels. Following the confirmation of significant differences through the ANOVA analysis, a Tukey HSD post-hoc test was conducted to precisely identify differences between individual pairs of industries. The results (Table 3) show that Financial and insurance activities have a statistically significantly higher average net wage compared to all other industries ($p < 0.05$). No significant differences were found in the remaining pairwise comparisons, indicating relative homogeneity among Construction, Trade, and Accommodation and food service activities.

Pair of industries	Mean difference	95% Confidence Interval	Significance
Wholesale and retail trade vs Construction	+76.50	[-92.12; 245.11]	n.s.
Accommodation and food service vs Construction	-20.36	[-188.97; 148.25]	n.s.
Financial and insurance activities vs Construction	+303.03	[134.41; 471.64]	$p < 0.05$
Accommodation and food service vs Wholesale and retail trade	-96.86	[-265.46; 71.75]	n.s.
Financial and insurance activities vs Wholesale and retail trade	+226.54	[57.92; 395.15]	$p < 0.05$
Financial and insurance activities vs Accommodation and food service	+323.39	[154.78; 492.00]	$p < 0.05$

Table 3: Tukey HSD Test Results for Pairwise Industry Comparisons
Source: author’s calculation

Table 3 presents the results of the Tukey HSD post-hoc test, which enabled a detailed comparison of average net wages across all pairs of industries. The results indicate that there are statistically significant differences between Financial and insurance activities and all other industries. Notably significant differences were found in the comparisons:

- *Financial and insurance vs Construction* (mean difference = +303.03 EUR; $p < 0.05$),
- *Financial and insurance vs Trade* (+226.54 EUR; $p < 0.05$),
- *Financial and insurance vs Accommodation and food services* (+323.39 EUR; $p < 0.05$).

The confidence intervals for these differences do not include zero, confirming their statistical significance. In contrast, no statistically significant differences were observed among the remaining industry pairs ($p > 0.05$), as reflected in the wide confidence intervals that include zero. For example, the difference between Trade and Construction (+76.50 EUR) is not statistically significant, given the 95% confidence interval of [-92.12; 245.11]. Similar results were found in the comparisons of *Accommodation and food services vs Trade* and *Accommodation and food services vs Construction*. These findings suggest that Financial and insurance activities stand out in terms of wage levels, while the other three industries exhibit a relatively homogeneous wage structure. This points to specific market and organizational factors within the financial sector that enable the payment of higher average net wages.

4.3. Dynamic trend analysis of average net wages and financial indicators

This subsection provides a detailed overview of changes in average net wages and key financial indicators during the period 2016–2023. The dynamic analysis enabled the tracking of trends, fluctuations, and patterns in the movement of variables, thereby establishing a solid scientific framework for interpreting observed differences among industries and for analyzing the interrelationship between economic indicators and wage levels. Graphical representations offer a visual insight into the movement of variables, facilitating the recognition of upward or downward trends over the years and allowing for a more detailed comparison of financial performance and employee compensation systems across industries.

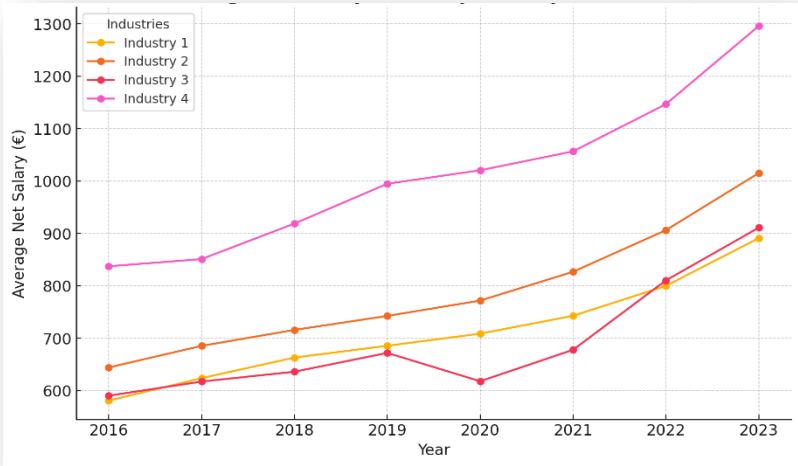


Figure 2. Trends in Average Net Wages in the Period 2016–2023
 Source: author’s calculation

Figure 2 illustrates the dynamics of average net wages across the four analyzed industries over seven years. Financial and insurance activities consistently record the highest levels of average net wages, with a notable upward trend between 2018 and 2020.

This sharp increase may be the result of specific market developments and increased demand for professionals in the financial sector. After 2020, wages in this industry stabilize at a high level, indicating a certain balance between business profitability and employee compensation systems. In contrast, Construction and Accommodation and food service activities show lower levels of average net wages with minimal fluctuations, which may suggest more rigid wage structures and limited room for growth. Wholesale and retail trade demonstrates moderate but steady wage growth in recent years, likely associated with the consolidation of the sector and adaptation to changes in consumer behavior.

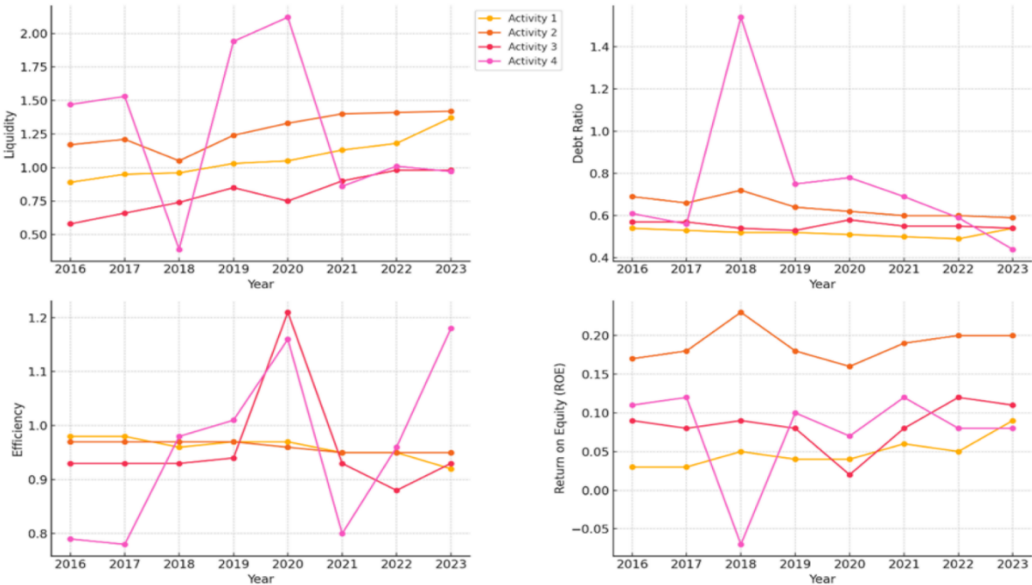


Figure 3: Trends in Financial Indicators (Liquidity, Indebtedness, Efficiency, and ROE) in the Period 2016–2023

Source: author’s calculation

Figure 3 illustrates the trends of key financial indicators by industry. Liquidity in Financial and insurance activities shows greater fluctuations than in other industries, with a marked decline in 2018 followed by a recovery. These oscillations may be the result of regulatory changes or capital market volatility, which directly affects the ability to meet short-term obligations. Indebtedness in financial activities remains at elevated levels compared to other sectors, indicating more intensive use of external financing sources, while Construction and Accommodation and food service activities demonstrate a more conservative financial position. Efficiency remained relatively consistent across industries throughout the observed period, with minimal fluctuations, indicating stable management of the revenue-to-expense ratio in the analyzed sectors. Return on equity (ROE) particularly highlights Wholesale and retail trade, which recorded the highest values for this indicator in most years. This suggests high sectoral efficiency in generating profit relative to invested capital. In contrast, Financial activities display ROE fluctuations, including a decline in 2018 and a subsequent recovery, possibly due to specific investment decisions and market developments.

4.4. Differentiated Analysis of the Relationship Between Financial Indicators and Wages by Industry

In order to gain a more precise understanding of the relationship between key financial indicators and average net wage levels, a Pearson correlation analysis was conducted separately for each of the observed industries.

This approach allows for the identification of specific patterns of association within individual industries, as well as for recognizing differences in financial structures and compensation systems across sectors. The following financial indicators were included in the analysis: liquidity, indebtedness, efficiency, and return on equity (ROE), while average net wage was defined as the main variable of interest. The resulting Pearson correlation coefficients (r) and their statistical significance (p) are presented in Table 4. The significance of the relationships was tested at standard confidence levels ($p < 0.05$; $p < 0.01$; $p < 0.001$).

Indicator	Industry 1	Industry 2	Industry 3	Industry 4
Liquidity ↔ Wage	0.99***	0.80**	0.86**	-0.22 (ns)
Indebtedness ↔ Wage	-0.25 (ns)	-0.80**	-0.50*	-0.36 (ns)
Efficiency ↔ Wage	-0.93***	-0.88***	-0.33 (ns)	0.66**
ROE ↔ Wage	0.89***	0.29 (ns)	0.61*	0.05 (ns)

Table 4. Correlation between financial indicators and average net wages by industry

Note: * $p < 0,05$; ** $p < 0,01$; *** $p < 0,001$; ns = not significant

Source: author's calculation

Table 4 clearly illustrates the differences in the strength and direction of the relationships between financial indicators and wage levels across the analyzed industries. In Construction, Trade, and Accommodation and food service activities, a very strong positive correlation was observed between liquidity and average net wages ($r > 0.80$; $p < 0.01$). This suggests that companies with greater ability to meet short-term obligations have more financial flexibility to compensate employees. Return on equity (ROE) also shows a strong positive correlation with wages in Construction ($r = 0.89$; $p < 0.001$), indicating that the ability to generate profit from invested capital may be a key factor in determining wage levels. In contrast, in Financial and insurance activities, liquidity and ROE do not show a significant relationship with wages, while efficiency stands out as the only significant indicator ($r = 0.66$; $p < 0.01$). This implies that in this sector, the efficiency of revenue and expense management is the dominant factor influencing wage policy. Indebtedness shows a negative relationship with wages in almost all industries, especially in Trade ($r = -0.80$; $p < 0.01$), which may indicate that higher reliance on external financing reduces the capacity to increase employee wages.

5. CONCLUSION

This study examined the relationship between key financial indicators and average net wages across four major industries of the Croatian economy: Construction, Wholesale and Retail Trade, Accommodation and Food Services, and Financial and Insurance Activities. The findings confirmed the existence of significant sectoral differences in how financial structures influence wage-setting practices. In real-sector industries, such as Construction, Trade, and Hospitality, a strong positive correlation was observed between liquidity, return on equity (ROE), and average wages. These results suggest that firms with greater solvency and profitability have more financial flexibility to offer competitive compensation. Conversely, indebtedness showed a negative correlation with wages in all sectors, particularly in Trade, indicating that high levels of external financing may constrain a company's ability to invest in its workforce. In contrast, the Financial and Insurance sector demonstrated a distinct pattern. Here, operational efficiency was the only indicator significantly associated with wage levels, while liquidity and ROE showed no statistical relevance. This suggests that in finance-related industries, internal cost control and operational performance are more critical to compensation strategies than traditional profitability metrics. These sector-specific patterns can be interpreted through the lens of efficiency wage theory, which posits that firms may offer higher wages to increase productivity and reduce turnover.

The findings align with existing empirical research, both internationally and within the European context, emphasizing the importance of financial stability in shaping wage systems. While the study provides important insights, it is not without limitations. The analysis was limited to four industries and relied on correlation methodology, which does not establish causality. Future research should include a broader range of sectors and apply advanced econometric models, such as panel regression or structural equation modeling, to explore the causal pathways between financial indicators and wage outcomes. Overall, this research highlights the crucial role of internal financial health in shaping compensation policies and reinforces the need for sector-specific approaches to human resource and financial management. The results offer a foundation for developing informed wage strategies and labor policies that reflect the structural realities of different industries within the Croatian economy.

LITERATURE:

1. Akerlof, G. A., & Yellen, J. L. (1990). The fair wage-effort hypothesis and unemployment. *The Quarterly Journal of Economics*, 105(2), 255–283. <https://doi.org/10.2307/2937787>
2. Blundell, R., Crawford, C., & Jin, W. (2013). *What can wages and employment tell us about the UK's productivity puzzle?* Institute for Fiscal Studies.
3. Dadebo, A. O., & Afolabi, O. F. (2020). Impact of liquidity management on profitability of selected manufacturing firms in Nigeria. *European Journal of Business and Management*, 11(27), 93–99. <https://doi.org/10.7176/EJBM/12-27-11>
4. Durrah, O., Abdul Rahman, A. A., Jamil, S. A., & Ghafeer, N. A. (2016). Exploring the Relationship between Liquidity Ratios and Indicators of Financial Performance: An Analytical Study on Food Industrial Companies Listed in Amman Bursa. *International Journal of Economics and Financial Issues*, 6(2), 435–441.
5. Eljelly, A. M. A. (2004). Liquidity–profitability tradeoff: An empirical investigation in an emerging market. *International Journal of Commerce and Management*, 14(2), 48–61. <https://doi.org/10.1108/10569210480000179>
6. Intrisano, C., Micheli, A. P., & Calce, A. M. (2019). Capital structure and performance: Evidence from European listed companies. *Journal of Business, Economics and Finance (JBEF)*, 8(4), 259–267. <https://doi.org/10.17261/Pressacademia.2019.1171>
7. McNulty, J. E., & Brady, D. (2022). Operating efficiency and compensation practices in financial institutions. *SSRN Working Paper*. <https://doi.org/10.2139/ssrn.4238855>
8. Oliveira, M. F. (2024). Capital structure and employee consumption. *Unpublished working paper*.
9. Ouimet, P., & Simintzi, E. (2015). Wages and firm performance: Evidence from the 2008 financial crisis. *NBER Working Paper No. 25125*
10. Ouimet, P., & Simintzi, E. (2015). Wages and firm performance: Evidence from the 2008 financial crisis. *NBER Working Paper No. 25125*.
11. Raff, D. M. G., & Summers, L. H. (1987). Did Henry Ford pay efficiency wages? *Journal of Labor Economics*, 5(4), S57–S86. <https://doi.org/10.1086/298164>
12. Ratajczak, P., Szutowski, D., & Nowicki, J. (2024). Exploring the dynamics of profitability–liquidity relations in crisis, pre-crisis and post-crisis. *International Journal of Financial Studies*, 12(1), 16. <https://www.mdpi.com/2227-7072/12/1/16>
13. Shapiro, C., & Stiglitz, J. E. (1984). Equilibrium unemployment as a worker discipline device. *The American economic review*, 74(3), 433–444.
14. Valeyre, A., Grebenkov, D., & collaborators. (2016). Should employers pay their employees better? An asset pricing approach. *arXiv preprint*. <https://arxiv.org/abs/1602.00931>

LITERACY AND EDUCATIONAL CONSTRAINTS IN THE LABOR-MARKET INCLUSION OF MARGINALIZED ROMA IN SLOVAKIA

Tomas Sarkozi

Bratislava University of Economics and Business, Slovakia
tomas.sarkozi@euba.sk

ABSTRACT

Marginalized Roma communities (MRC) in Slovakia face persistent labour-market exclusion that is closely linked to long-term segregation and cumulative educational disadvantages. This article connects Slovakia's active labour market policy (ALMP) approach, where participation among Roma is concentrated in activation works, with evidence on education- and skills-related constraints that shape program access and effectiveness. Using descriptive evidence from the EU Survey on Income and Living Conditions-Roma module for Slovakia (SILC_MRK 2020), the article documents large gaps between MRC and the overall population in early childhood education participation, special education placement, early school leaving, and NEET status, alongside major differences in educational attainment. These educational deficits imply weak foundations in literacy and skills that reduce eligibility for and returns to training-based measures and limit transitions into standard employment. To assess employment effects directly, the article draws on analysis using two waves of the EU-SILC Roma modules (2018 and 2020), defining treatment as participation in activation works in the year before the 2020 survey and comparing participants with similar non-participants over time. The findings indicate that activation works are not associated with improved short-term employment for MRC, consistent with the interpretation that such programs function primarily as temporary income support rather than pathways to sustained jobs. The results underscore the need to complement activation works with policies that strengthen education, literacy, and skills formation and reduce structural barriers to regular employment.

Keywords: *Activation works, Active labour market policies, Educational deficits, Marginalized Roma communities*

1. INTRODUCTION

Historically, Roma marginalization is widely understood as a long-term structural process shaped by discrimination, exclusion, and unequal access to key resources (Hammarberg, 2011). The policies across the Habsburg lands, including territories that are part of present-day Slovakia, attempted to control Roma communities through forced settlement and assimilation-oriented measures. These interventions framed Roma as a group to be managed administratively, helping to establish durable patterns of separation and unequal treatment rather than inclusion on equal terms (Council of Europe, 2006). In the twentieth century, Roma persecution during the Second World War deepened vulnerability and stigma, including detention practices affecting Roma in Slovakia. Under state-socialist governance, Roma-related policies often combined “integration” language with top-down interventions that reshaped communities without removing underlying prejudice, contributing to the persistence of separation in everyday life (Institute of National Memory, 2017; Council of Europe, 2009). After 1989, segregation increasingly became visible through spatial patterns and local practices, including the concentration of Roma in separated settlements or neighborhoods and in some cases, physical barriers reinforcing division. Monitoring bodies and media accounts describe how these dynamics sustain exclusion and anti-Roma attitudes, leaving many Roma settlements with weaker infrastructure and reduced access to services and opportunities.

Taken together, these historical and contemporary processes have contributed to Roma settlements that remain socially and spatially cut off from the rest of society, reproducing disadvantage across generations (Hammarberg, 2011). In this context, marginalized Roma communities (MRC) can be understood as segregated Roma settlements that face the combined effects of social exclusion, ethnic stigmatization, and spatial segregation over the long term. The estimated count of Roma in Slovakia is approximately 400,000 and includes those integrated into mainstream society (Almašiová et al., 2025). Based on the Atlas of Roma Communities 2019, aggregating settlement populations yields an indicative total of approximately 262,000 people living in the mapped Roma settlements (Office of the Plenipotentiary of the Government of the Slovak Republic for Roma Communities, 2019). MRC are among the most vulnerable groups, and marginalization affects not only their economic situation but also health, education, and overall quality of life (Almašiová et al., 2025). During the EU-SILC survey for MRC conducted in Slovakia in 2020, the self-reported employment rate among working-age people (20–64) in MRC was 23%, compared with 76% in the overall population (Markovič & Plachá, 2022). Living conditions indicators point to very high economic insecurity. In 2020, 87% of people in MRC were below the EU-SILC at-risk-of-poverty threshold, versus 11% in the overall population. Average monthly net household income in MRC which is 2.3 times lower than in the overall population, and 52% of people in MRC lived in households experiencing severe material deprivation compared with 6% overall (Markovič, Plachá, 2022). Barriers and unequal treatment extend beyond income. 26% of MRC households reported difficulties accessing healthcare. In the year prior to the survey, reported discrimination on the grounds of ethnic origin was experienced by 23% of Roma men and 19% of Roma women when looking for work, employment, housing, healthcare, education, or during contact with authorities or services (Markovič, Plachá, 2022). This paper contributes to the literature on Roma labor-market inclusion by linking macro-level policy approaches with micro-level constraints. By connecting Slovakia's ALMP-centered integration approach with evidence on education-related constraints, it highlights why such barriers can limit transitions into regular employment. The paper is structured as follows: Chapter 2 describes the current policy framework for labor-market integration, focusing on ALMP instruments, and Chapter 3 analyses educational deficits to show why these constraints can reduce policy effectiveness and help explain limited labor-market outcomes for MRC.

2. POLICY FRAMEWORK

The current policy framework in Slovakia addressing the socio-economic situation of Roma sits at the intersection of EU-level commitments on Roma equality and inclusion and national strategies, most notably the Strategy for Equality, Inclusion and Participation of Roma until 2030, which positions labor market inclusion as part of a wider package encompassing education, health, housing, and measures to tackle anti-Roma racism. In the employment domain, Slovakia's primary operational instruments to reduce unemployment are implemented through ALMPs, alongside passive income support and other structural policies that shape employability and job availability (Kalužná, 2008). In practice, Slovakia's ALMP toolbox is usually delivered through the Public Employment Services and clusters into a few recurring instrument types. First, employer-side incentives (wage subsidies/allowances for hiring disadvantaged jobseekers) aim to reduce the cost/risk of hiring and create formal jobs and are typically framed as "regular employment" entry measures rather than temporary work (Central Office of Labor, Social Affairs and Family, 2026). Second, human-capital measures focus on employability through training, re-skilling, and job-search support. In Roma-related contexts, these measures interact strongly with baseline educational disadvantage and early school leaving, which affects both eligibility for and the effectiveness of training-based activation (Holubová et al., 2021).

Third, Slovakia has relied heavily on work-experience and municipal work-type activation programs (often discussed as “activation works”). Research repeatedly notes that these programs can provide short-run income support and maintain work routines, but they often struggle to produce sustained transitions into standard employment—especially in regions with few vacancies and among groups facing discrimination (Kureková, 2013; Karasová et al., 2019). This matters for Roma inclusion because participation in Slovakia’s ALMP mix is not evenly distributed across instruments: Roma in Slovakia, tend to gravitate most strongly toward activation works, while they are much less represented in measures with higher integration potential, particularly employer-linked employment incentives and training (Bednarik et al., 2019). Looking across ALMP participation more broadly, OECD evidence confirms this concentration, reporting that almost half of Roma participating in ALMPs participate in activation works, whereas only about one tenth participate in training programs; the same analysis finds Roma are around three times less likely than the general population to take part in employment-incentive schemes or training, reinforcing the pattern that Roma participation clusters in activation works rather than measures that more often support lasting post-program employment (Bednarik et al., 2019).

2.1. Summary of the authors’ empirical analysis

This section moves from describing the policy mix to testing whether participation in activation works is associated with better employment outcomes for MRC. Using two waves of the EU-SILC Roma modules (2018 and 2020), we compared program participants with similar non-participants and tracked changes in employment over time. While both groups started from almost identical employment levels in 2018 (11%), by 2020 employment increased in the comparison group (6 p.p) but declined among participants (-5.6 p.p.), resulting in a difference of 11.6 percentage points between the two groups. Overall, the findings suggest that activation works did not improve short-term employment for MRC and are more consistent with temporary income support than with a pathway to sustained jobs (Sarkozi, Kahanec, 2025).

3. EDUCATIONAL DEFICITS

Human-capital-building ALMPs: Training and re-skilling programs generally require basic literacy/numeracy and the ability to complete coursework and obtain recognized credentials; when successful, they raise productivity and improve matching to available jobs. By contrast, activation works are closer to income support and work routine maintenance and, across the evaluation literature, tend to show weaker post-program employment effects than job-search assistance or human-capital programs (Card et al., 2015). Education therefore acts as a multiplier for ALMPs that build skills, and as a constraint where low schooling limits which measures people can realistically enter or complete (Plavgo, 2023). Higher education increases the probability that ALMP participation has a positive employment outcome, while low education shifts participants toward measures with weaker integration potential. This is consistent with evidence from Slovakia that Roma are substantially under-represented in training and employment-incentive measures and over-represented in activation works-type schemes, which are less likely to deliver durable transitions into standard employment (Bednarik et al., 2019; Kureková, 2013). In the Slovak Roma context specifically, baseline educational disadvantage and early school leaving are repeatedly identified as central barriers that limit both employability and the effectiveness of activation/training measures (Holubová et al., 2021). In the Slovak Roma context specifically, baseline educational disadvantage and early school leaving are repeatedly identified as central barriers that limit both employability and the effectiveness of activation/training measures (Holubová et al., 2021).

Descriptive evidence from EU-SILC_MRK 2020 illustrates the scale of these disparities: in 2020, educational participation and outcomes differed sharply between MRC and the overall population. While roughly a third (32%) of children aged 3–6 from MRC attended kindergarten, 87% of children in the overall population did so (Markovič & Plachá, 2022). Among children aged 6–15 from MRC, 17% were placed in special education—about three times higher than in the overall population (Markovič & Plachá, 2022). Early school leaving is also far more prevalent in MRC: 83% of adults from MRC ended their schooling early, compared with 10% in the overall population (Markovič & Plachá, 2022). These disparities continue into youth transitions: almost two thirds (67%) of MRC young people aged 16–24 were neither in education, employment, nor training (NEET), compared with 12% in the overall population (Markovič & Plachá, 2022). At EU level, the Roma–non-Roma literacy gap is visible both in basic literacy and in digital skills: around 20% of Roma (16+) report being unable to read and write, compared with less than 1% of non-Roma living nearby (FRA, 2014). Similarly, only 19% of Roma adults are reported to have basic digital skills, compared with over 50% in the general population (Roma Civil Monitor, 2025). The gaps are reflected in the education-attainment distribution shown in Figure 1.

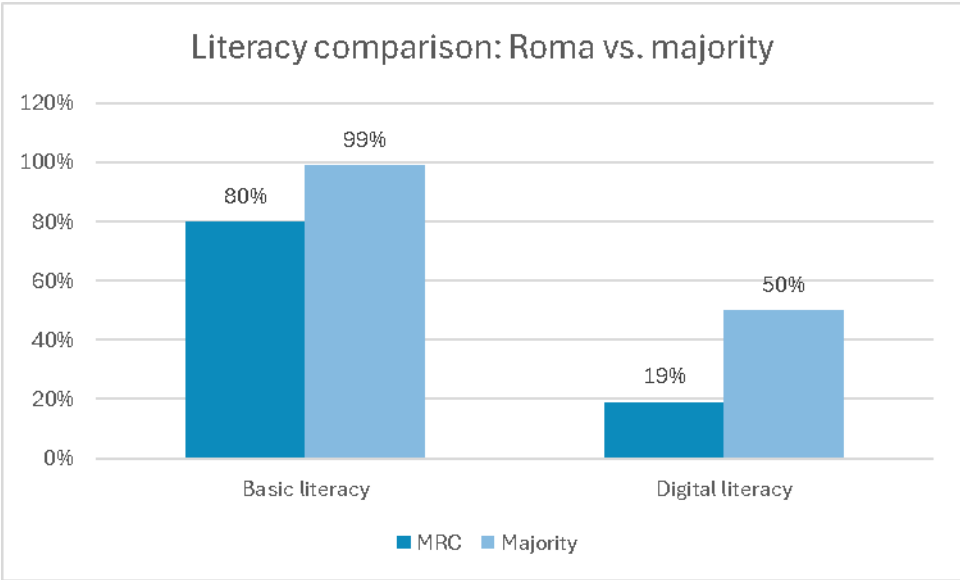


Figure 1: Literacy comparison: Roma vs. majority
(Source: EU SILC_MRK 2020)

The education-attainment profile also differs sharply between people living in MRC and the overall population. In MRC, the largest share has completed only lower levels of schooling, with 56% ending at primary education (2nd stage, Grades 5–9) and another 10% at primary education (1st stage, Grades 1–4); 2% report no education at all. MRC also shows a much higher share of special primary school (14%). By contrast, the overall population is concentrated at higher levels: 40% have upper secondary education with a school-leaving exam (Maturita) and 21% have university education, compared with only 2% and 1% in MRC, respectively. Vocational pathways also differ: apprenticeship/vocational training accounts for 12% in MRC versus 24% in the overall population. As shown in Figure 2, the concentration of MRC at low education levels helps explain why training-based measures may have limited reach and impact.

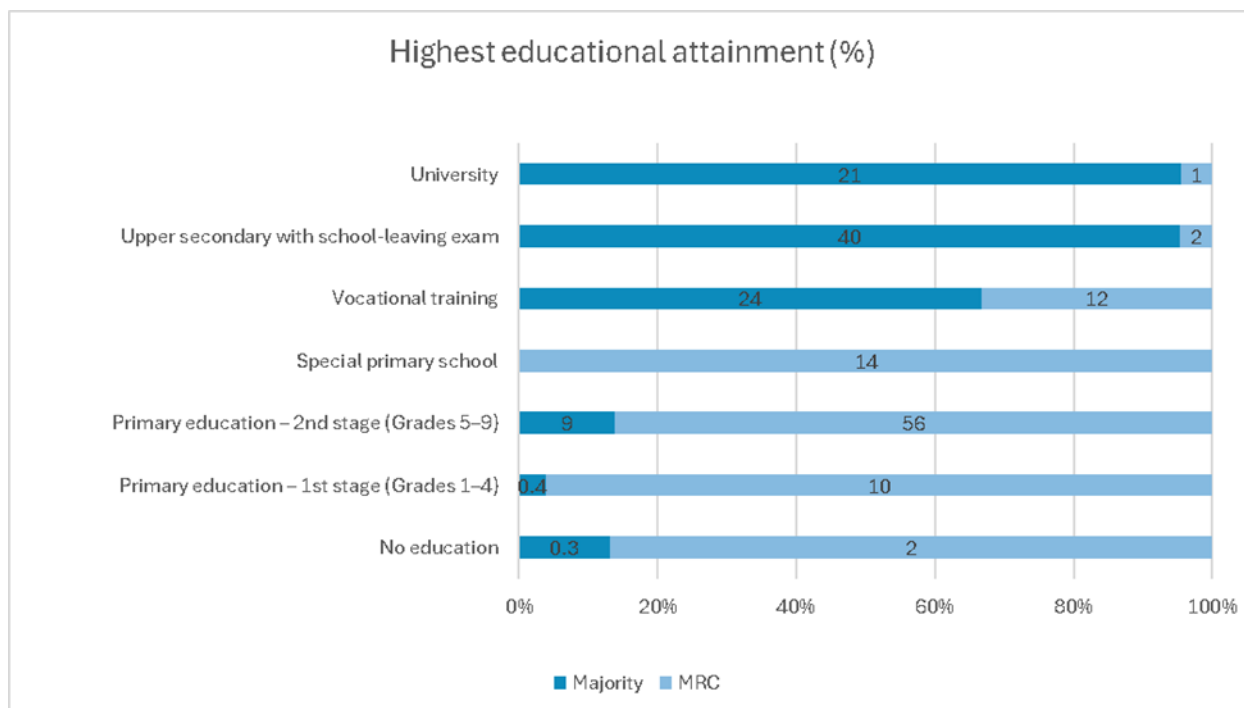


Figure 2: Highest educational attainment (% of population)
(Source: EU SILC_MRK 2020)

4. CONCLUSION

Overall, the evidence indicates that MRC in Slovakia face persistent labor-market exclusion that is closely linked to deep and cumulative educational deficits across the life course. These include low participation in early childhood education, elevated placement in special education, very high rates of early school leaving, and a large share of youth who are neither in education, employment nor training. Together, these patterns translate into weak basic skills and low formal qualifications, which in turn limit both access to and the effectiveness of skill-building ALMP measures—especially training and re-skilling programs that require literacy, learning capacity, and recognized credentials. At the same time, Roma participation in ALMPs concentrates in activation works rather than training or employer-incentive programs with higher integration potential, and available findings suggest that activation works do not improve short-term employment outcomes, functioning more as temporary income support than a pathway to sustained jobs.

LITERATURE:

1. Almašiová, A., Holdoš, J., & Izrael, P. (2025). *Marginalized Roma communities: Internet use from the perspective of risk experiences*. Bratislava: Ministry of Labour, Social Affairs and Family of the Slovak Republic. Retrieved 30.01.2026 from https://nks.gov.sk/wp-content/uploads/2025/06/MRK_Vyskumna_sprava-4-_compressed.pdf.
2. Bednarik, M., Hidaš, S., & Machlica, G. (2019). *Enhancing the social integration of Roma in Slovak Republic*. Paris: OECD Publishing. Retrieved 30.01.2026 from https://www.oecd.org/content/dam/oecd/en/publications/reports/2019/05/enhancing-the-social-integration-of-roma-in-slovak-republic_4aa7e41d/197eb309-en.pdf.
3. Card, D., Kluve, J., & Weber, A. (2015). *What works? A meta analysis of recent active labor market programs* (NBER Working Paper no. 21431). Cambridge, MA: National Bureau of Economic Research. Retrieved 30.01.2026 from https://www.nber.org/system/files/working_papers/w21431/w21431.pdf.

4. Central Office of Labour, Social Affairs and Family (ÚPSVaR). (2026). *Allowance for support of employment of disadvantaged job seeker*. Bratislava: Central Office of Labour, Social Affairs and Family. Retrieved 30.01.2026 from https://www.upsvr.gov.sk/sluzby-zamestnanosti/nastroje-aktivnych-opatreni-trhu-prace/prispevky-pre-zamestnavateľa/prispevok-na-podporu-zamestnavania-znevychodnenedo-uchadzaca-o-zamestnanie-50.html?lang=en&page_id=293050.
5. Council of Europe. (2006). *Factsheets on Romani history: Austro-Hungarian Empire*. Strasbourg: Council of Europe. Retrieved 30.01.2026 from <https://rm.coe.int/austro-hungarian-empire-factsheets-on-romani-history/16808b19ed>.
6. Council of Europe. (2009). *State policies under Communism*. Strasbourg: Council of Europe. Retrieved 30.01.2026 from https://www.coe.int/t/dg4/education/roma/source/fs/6.1_communism.pdf.
7. European Union Agency for Fundamental Rights. (2014). *Education: The situation of Roma in 11 EU Member States*. Vienna: European Union Agency for Fundamental Rights. Retrieved 30.01.2026 from https://fra.europa.eu/sites/default/files/fra_uploads/fra-2014-roma-survey-dif-education-1_en.pdf.
8. Hammarberg, T. (2011). *Report by the Commissioner for Human Rights of the Council of Europe on Slovakia*. Strasbourg: Council of Europe. Retrieved 30.01.2026 from <https://rm.coe.int/16806db7c5>.
9. Holubová, B., Kahanec, M., Kováčová, L., Poláčková, Z., & Sedláková, M. (2021). *The social and employment situation of Roma communities in Slovakia*. Brussels: European Parliament. Retrieved 30.01.2026 from https://www.europarl.europa.eu/RegData/etudes/STUD/2021/695466/IPOL_STU%282021%29695466_EN.pdf.
10. Institute of National Memory (ÚPN). (2017). *The Romani Holocaust*. Bratislava: Institute of National Memory (ÚPN). Retrieved 30.01.2026 from https://www.upn.gov.sk/data/files/skladacky-2017-7_8.pdf.
11. Kalužná, D. (2008). *Main features of the public employment service in the Slovak Republic*. Paris: OECD. Retrieved 30.01.2026 from https://www.oecd.org/content/dam/oecd/en/publications/reports/2008/11/main-features-of-the-public-employment-service-in-the-slovak-republic_g17a1c2e/230166268277.pdf.
12. Kureková, L. M. (2013). *Implementation of activation works in Slovakia*. Bratislava: Slovak Governance Institute. Retrieved 30.01.2026 from https://stary-web.governance.sk/assets/files/publikacie/ACTIVATION_WORKS_REPORT_SGI.pdf.
13. Markovič, F., & Plachá, I. (2022). *Income and living conditions in marginalized Roma communities: Selected indicators from the EU SILC_MRC 2020 survey*. Bratislava: Office of the Plenipotentiary of the Government of the Slovak Republic for Roma Communities (ÚSVRK). Retrieved 30.01.2026 from https://www.romovia.vlada.gov.sk/site/assets/files/1561/analyticka_sprava_eu_silc_mrk_2020_elektronicka_final.pdf.
14. Office of the Plenipotentiary of the Government of the Slovak Republic for Roma Communities (ÚSVRK). (2019). *Atlas of Roma Communities 2019*. Bratislava: Office of the Plenipotentiary of the Government of the Slovak Republic for Roma Communities (ÚSVRK). Retrieved 30.01.2026 from <https://www.romovia.vlada.gov.sk/atlas-romskych-komunit/atlas-romskych-komunit-2019/>.
15. Roma Civil Monitor. (2025). *Digital inclusion of Roma: Current patterns, trends, and barriers*. Brussels: Roma Civil Monitor. Retrieved 30.01.2026 from https://democracyinstitute.ceu.edu/sites/default/files/article/attachment/2025-01/RCM_2025_Thematic-report-DIGITAL-final-ISBN.pdf.
16. Sarkozi, T., & Kahanec, M. (2025). *Do public employment programs benefit marginalized communities? Evidence on employment effects for marginalized Roma in Slovakia* [under review]. Berlin: Journal of Population Economics

DIGITAL TRANSFORMATION OF CULTURAL CONTENT: MUSEUMS BETWEEN ALGORITHMICALLY MEDIATED PLATFORMS AND IMMERSIVE TECHNOLOGIES

Hrvoje Mesic

*J. J. Strossmayer University in Osijek, Croatia
Academy of Arts and Culture
hrvoje.mesic35@gmail.com*

Filip Kranjcevic

*J. J. Strossmayer University in Osijek, Croatia
Academy of Arts and Culture
fkranjcevic02@gmail.com*

Vigor Marosevac

*J. J. Strossmayer University in Osijek, Croatia
Academy of Arts and Culture
vigor.marosevac@gmail.com*

ABSTRACT

The paper analyses the digital transformation of cultural content with a particular focus on museums as institutions situated between the logic of algorithmically mediated platforms and the development of immersive technologies. Drawing on an interdisciplinary theoretical framework encompassing cultural studies, museology, media studies, and digital humanities, the paper examines the processes of cultural platformization, the digitalization of cultural heritage, and the application of virtual and augmented reality in the museum context. Digital transformation is interpreted as a complex socio-cultural process that reshapes the modes of production, distribution, interpretation, and consumption of culture, in which digital technologies and algorithmic systems participate in structuring cultural visibility, accessibility, and the valuation of content. Particular attention is given to the changing role of audiences and the strengthening of participatory models of museum practice, in which visitors are gradually transformed from passive observers into active participants in experience and learning. The paper also addresses key challenges of digital transformation, including privacy and the processing of user data, copyright and digital content management, digital inequality, and the algorithmic mediation of cultural diversity and the potential homogenization of taste. In conclusion, the paper emphasizes that the future of museums in the digital environment does not lie in complete virtualization, but rather in the development of balanced hybrid models that connect the physical experience of encountering heritage with the possibilities offered by digital and immersive technologies. The paper contributes to an understanding of museums as hybrid institutions at the intersection of technology, culture, and society, and highlights the need for strategic and ethically grounded approaches to digital transformation in the cultural sector.

Keywords: *digital transformation, cultural platformization, algorithmic mediation, immersive technologies (VR/AR), digitalization of cultural heritage, museums*

1. INTRODUCTION: FROM CULTURAL INSTITUTIONS TO DIGITAL ECOSYSTEMS

Digital technologies and platforms increasingly shape contemporary patterns of cultural production, distribution, and consumption, with algorithmic systems becoming key mediators of cultural visibility and accessibility (Richieri Hanania, 2022).

In this context, digital transformation is increasingly described as a complex socio-cultural process rather than merely a technological change (Terras, 2012). The development of digital platforms, algorithmic systems, and immersive technologies affects not only the media and creative industries but also fundamental cultural institutions such as museums, galleries, and archives. Culture is progressively shifting from exclusively physical spaces into hybrid and virtual environments, redefining relationships between institutions, creators, and audiences. Within this framework, digital platforms become dominant intermediaries of cultural distribution. Streaming services and social media enable on-demand access to content with a high level of personalization based on algorithmic recommendations, which directly influences patterns of cultural consumption and perceptions of content value (Richieri Hanania, 2022). At the same time, this model expands access to culture while raising questions about the homogenization of taste, commercialization, and the algorithmic mediation of cultural diversity. Museums occupy a particularly sensitive position within this digital ecosystem. As institutions whose fundamental mission is the preservation, research, and interpretation of cultural heritage, museums are confronted with the need to adapt to contemporary communication practices and audience expectations. The digitalization of museum collections represents a key prerequisite for integrating museums into broader digital flows, while the development of virtual and augmented reality enables the creation of immersive experiences that transcend the limitations of physical space (Bekele and Champion, 2019; Dieck and Jung, 2017). The application of VR and AR technologies in the museum context facilitates new models of heritage interpretation and communication, in which technology becomes a means of shaping participatory and educationally effective experiences (Economou and Meintani, 2011). Visitors are thus gradually transformed from passive observers into active participants in the cultural process, which constitutes one of the key shifts in contemporary museum practice. The introduction of digital technologies into the museum context can also be examined through the broader framework of heritage culture and cultural memory, according to which heritage does not represent a static set of objects but rather a dynamic system of meanings that is continuously reconfigured in relation to space, community, and identity. Heritage institutions do not merely preserve objects; they materialize social memory through practices of selection, interpretation, and representation, thereby participating in the construction of the cultural identity of places and communities. The digital transformation of museums further intensifies this dimension, as digital records, virtual collections, and online interpretations become new forms of inscription and circulation of cultural memory. Such a shift can be linked to an understanding of heritage as a dynamic system of meanings constantly reconfigured in relation to space, emotion, and identity, in which interpretation takes place not only within the museum but also within digital ecosystems where audiences participate, respond, and co-create the meaning of heritage (Mesić, 2019; Mesić, 2022). Building on the above, the aim of this paper is to analyse the digital transformation of cultural content with a focus on museums as institutions situated between the logic of algorithmically mediated digital platforms and the development of immersive technologies. The paper brings together theoretical insights from cultural studies, museology, media studies, and digital humanities in order to examine the potentials, limitations, and challenges of applying digital and immersive technologies in the museum environment. Methodologically, the paper is based on qualitative conceptual analysis and the thematic synthesis of relevant scholarly literature. The corpus includes works from cultural and media studies (platformization, algorithmic visibility), museology (interpretation, audiences, curatorial strategies), and digital humanities and heritage studies (digitalization, representation, cultural memory). The units of analysis consist of key concepts and their interrelations: cultural platformization, algorithmic mediation, heritage digitalization, VR/AR interpretation, participatory models of museum practice, and ethical challenges (privacy, copyright, inequality, transparency of interpretation).

The structure of the paper is organized so as to first present the theoretical framework of digital transformation and cultural platformization, followed by a discussion of the processes of cultural heritage digitalization and the development of VR/AR technologies, and finally an analysis of integration strategies, audience impacts, and key challenges. The digital entry of cultural institutions into online spaces does not take place within a neutral technological environment, but rather within infrastructural frameworks shaped by commercial platforms and their algorithmic systems. The question of digital transformation therefore moves beyond the level of tools to the level of institutional logic: it raises the issue of the extent to which museums retain autonomy in shaping interpretative narratives, and the extent to which they adapt to the logics of visibility, engagement, and metrics that characterize digital ecosystems. The digital transformation of museums entails not only the implementation of new technologies, but also the redefinition of institutional identities, professional roles, and relationships with audiences. In this sense, museums are increasingly described as post-digital institutions in which clear boundaries between physical and digital experience are blurred, and both spaces are understood as intertwined dimensions of the same cultural practice (Nikolaou, 2024). It is important to emphasize that the challenges of artificial intelligence are often mistakenly interpreted as purely technological problems, whereas they are primarily connected to social values and modes of technology use. Vertovšek warns that the danger does not arise primarily from artificial intelligence itself, but from the ways in which humans develop, use, and instrumentalize it in accordance with profit-driven, military-industrial, and corporate interests (Vertovšek, 2025). Consequently, the ethical issues of the digital transformation of culture cannot be reduced solely to the regulation of technology, but must also include the responsibility of cultural institutions in shaping value-based and interpretative frameworks.

2. DIGITAL TRANSFORMATION OF CULTURAL CONTENT AND THE PLATFORMIZATION OF CULTURE

The development of streaming platforms and digital services has established new patterns of cultural content consumption based on on-demand availability and personalized recommendations (Lozić, 2020). Digital technologies do not function merely as new tools; they actively participate in shaping the values, meanings, and visibility of cultural content. In this sense, digital media can be understood as cultural infrastructures that structure not only content distribution, but also the conditions of cultural production and reception. Artificial intelligence increasingly operates as an integral part of this infrastructural environment, that is, as a broader techno-cultural milieu influencing economic, communicative, and social relations. Vertovšek emphasizes that artificial intelligence today cannot be viewed solely as an individual tool or program, but rather as a complex environment that reshapes relationships between people, media, and technology (Vertovšek, 2025). Such an understanding further supports the argument that the platformization of culture is not merely a change in distribution channels, but a transformation of the cultural conditions within which meanings are produced, valued, and circulated. One of the key features of contemporary digital culture is platformization. Digital platforms, such as streaming services, social media, and specialized cultural portals, have become dominant intermediaries between producers and audiences. In this context, platforms can be described as algorithmically mediated, as the visibility, accessibility, and recommendation of content are largely based on automated systems that analyse user data and shape individualized flows of cultural content. Their business and communication model is grounded in the platform economy, in which access to content replaces physical ownership, and distribution takes place through digitally networked ecosystems with global reach. The platformization of culture therefore entails not only a change in distribution channels, but also a shift in power relations within the cultural field.

Commercial platforms increasingly function as infrastructural prerequisites for the visibility of cultural content, placing cultural institutions in a position where they must adapt to the rules of ecosystems that are not primarily oriented toward the preservation of cultural values, but toward the maximization of engagement and profit. This context requires museums to develop strategies that simultaneously leverage the potentials of platforms while retaining autonomy in shaping their own interpretative and communicative practices. Streaming services represent a paradigmatic example of the platformization of culture, as by introducing on-demand content models and algorithmic personalization they enable users to have individualized content consumption experiences, replacing linear distribution models with flexible and personalized patterns (Lozić, 2020; Lozić, Fotova Čiković, and Vuković, 2021). Such models transform not only user habits but also the very structure of cultural production, as algorithmic systems increasingly influence decisions regarding visibility, recommendations, and investments in particular types of content. Algorithmic personalization offers a number of advantages, including easier content discovery and greater alignment with individual interests. However, it simultaneously raises questions concerning cultural diversity and the homogenization of taste. When algorithms prioritize content that is already popular or that aligns with users' previous preferences, there is a risk of creating bubbles in which exposure to different aesthetic and cultural expressions is reduced (Richieri Hanania, 2022). In this way, digital platforms position themselves not only as technological intermediaries but also as cultural actors participating in the shaping of the cultural canon. The digital transformation of platform ecosystems has been further intensified by the development of artificial intelligence tools that participate not only in distribution but also in the automated creation of media content. Contemporary language, image, voice, and video tools enable the generation of content ready for consumption, thereby transforming the relationship between authors, technology, and audiences and accelerating the circulation of cultural meanings (Bebić, 2023). Artificial intelligence thus operates not merely as an auxiliary tool, but as a participant in shaping content, value, and visibility, further underscoring that digital media function as cultural infrastructures that structure the conditions of production and reception. Digital transformation also affects the role of audiences. Audiences are increasingly viewed less as passive consumers and more as active participants in the cultural process. Through commenting, sharing, rating, and creating their own interpretations, users take part in the circulation of meanings and in the construction of the symbolic value of content. This shift contributes to the democratization of access to culture, but at the same time may lead to the superficialization of content and the strengthening of commercial logics that favor quantity over quality. In the context of cultural institutions, the platformization of culture poses additional challenges. Museums, galleries, and archives are no longer exclusive spaces for encountering cultural heritage, but become part of a broader digital ecosystem in which they compete for audience attention with commercial platforms and media content. This does not necessarily imply a loss of their social role, but rather the need to redefine communication and interpretative strategies. Algorithmic systems do not operate solely as mechanisms for filtering content, but as active participants in the process of cultural valuation: they shape hierarchies of visibility and indirectly determine which themes, genres, and aesthetic expressions will be privileged and which marginalized. In this context, it is important to emphasize that generative artificial intelligence systems, despite their impressive productivity, have limitations in the domain of originality and uniqueness. In an experimental study comparing human and AI proposals in the field of branding, Haramija (2025) demonstrates that AI-generated proposals do not meet the criterion of uniqueness, whereas some human participants produce original solutions. These findings suggest that algorithmically generated content is often based on the recombination of existing patterns, which reinforces the need for critical evaluation and transparency in their use within the cultural field.

In this sense, the platformization of culture can be understood as an infrastructure of cultural visibility that participates in the formation of the contemporary cultural canon. Cultural institutions therefore no longer operate solely as producers and custodians of content, but also as actors who must understand platform logics in order to secure the presence and recognizability of their own programmes. Moreover, platformization encourages a shift from models of public cultural service toward models based on attention and engagement. The value of content is increasingly measured through quantitative indicators such as views, shares, and time spent, which may be in tension with the long-term educational and cultural goals of museums and alters the ways in which institutions plan their communication. Such a context further underscores the need for museums to develop their own digital strategies that enable the use of platforms without full subordination to their commercial logics. In this context, the digitalization of cultural heritage emerges as a key operational mechanism through which museums establish their presence within digital ecosystems. However, it is important to emphasize that museums' entry into digital ecosystems entails not only the presence of content, but also the transfer of institutionally constructed narratives into a media environment in which meaning is more rapidly fragmented, recontextualized, and affectively redirected. The concept of heritage as a constitutive element of identity and emotion opens an additional analytical level: a digital platform does not merely distribute information about heritage, but also mediates affective responses, a sense of belonging, and users' symbolic identification with cultural content. When heritage is understood as a field in which cultures of memory, emotional communities, and identity projections intersect, the platformization of culture also becomes a question of how algorithmically mediated visibility influences which forms of heritage are perceived as important, as "ours," or as relevant (Mesić, 2022).

3. DIGITALIZATION OF CULTURAL HERITAGE AND IMMERSIVE TECHNOLOGIES

Immersive technologies such as virtual and augmented reality are increasingly applied in the field of cultural heritage in order to enable new forms of interpretation and user experience (Bekele and Champion, 2019). The digitalization of cultural heritage represents one of the fundamental processes of the contemporary digital transformation of culture, encompassing the conversion of analogue cultural objects and practices into digital records and their further processing and contextualization (Terras, 2012). The digitalization of cultural heritage fulfils multiple roles: it contributes to the long-term preservation of endangered tangible and intangible assets and enables their accessibility to broader and geographically dispersed audiences. Virtual museums, online collections, and open databases are becoming important tools for research, education, and the popularization of cultural heritage, thereby extending the social reach of cultural institutions. In the context of virtual museums, an additional experiential dimension can be achieved through multisensory interaction. Research by Gayathri and Nam (2024) shows that the inclusion of a finger-specific vibrotactile feedback interface (FSVF) in a virtual museum environment improves task accuracy and efficiency, the sense of immersion, and user satisfaction in interactions with virtual objects. This finding indicates that the integration of haptics can deepen engagement and the perceptual quality of virtual museums, and strengthens the argument that digital and immersive technologies in museum practice do not serve merely as a visual-auditory enhancement, but also as a means of multisensory experience and more intensive interaction with cultural content. The development of immersive technologies, primarily virtual reality (VR) and augmented reality (AR), directly builds upon processes of digitalization. VR technology enables the creation of fully virtual environments in which users can explore reconstructed spaces, objects, and historical situations, while AR overlays the physical environment with digital layers of information (Bekele and Champion, 2019; Dieck and Jung, 2017).

In an early and influential study, Carrozzino and Bergamasco (2010) emphasize that immersive VR technology has the potential to transform museum presentation by enhancing the sensory and interactive dimensions of visitor experience. The authors propose a classification of VR installations in the cultural context according to levels of interactivity and immersion, and indicate that such experiences can improve communication with audiences and expand access to cultural heritage, although they remain relatively rare in practice due to cost and organizational barriers. A broader review of the application of eXtended Reality (XR) technologies in museum practice shows that the combination of AR, MR, and VR approaches enables the creation not only of immersive virtual environments, but also of multisensory, interactive experiences that go beyond classical digital presentations and encourage deeper audience engagement in the interpretation of cultural heritage (Silva and Teixeira, 2022). In the museum context, these technologies enable new forms of interpretation that go beyond static exhibition models and introduce dynamic, interactive, and experiential approaches. Contemporary digitalization methods include 3D scanning, photogrammetry, laser scanning, and high-resolution photography, while techniques based on artificial intelligence are increasingly used for the reconstruction of damaged or missing parts of objects. In this context, it is important to emphasize that generative AI systems do not produce original meanings, but rather transform and recombine existing cultural patterns. Haramija (2025) demonstrates that artificial intelligence in creative tasks often produces formulaic solutions, whereas original proposals are more strongly associated with human participants. This implies that, in the museum context, artificial intelligence can play the role of an assistive tool in the processing and visualization of heritage, but not that of an autonomous bearer of interpretation. Digitalization approaches enable a high level of precision and the creation of detailed digital models that can be integrated into VR and AR applications. At the same time, the development of computing infrastructure and cloud solutions allows for the storage and sharing of large volumes of data, thereby increasing the interoperability and long-term sustainability of digital collections. The development of generative artificial intelligence further expands the possibilities of digital heritage processing by enabling the automated creation, augmentation, and transformation of textual, visual, and audiovisual content. Such tools make it possible to convert text into images, images into video, and to generate new visual variations of existing records, opening new opportunities for the interpretation and narrative treatment of heritage in digital environments (Bebić, 2023). In this way, digitalization increasingly shifts from mere documentation toward creative reconstruction and reinterpretation of cultural content, which requires clear curatorial and ethical frameworks. Research in the Croatian context confirms the importance of immersive technologies in the interpretation of cultural heritage. Mavrin, Mesić, and Pavin Banović (2023) emphasize that eXtended Reality (XR) and gamification are increasingly recognized as important elements of contemporary heritage presentation, as they enable the transformation of non-visitors into visitors and open new channels of communication with audiences. The authors emphasize that through immersive and gamified content, museums can create polysensory experiences that combine visual, auditory, and interactive elements, thereby deepening the experience of heritage and encouraging users' emotional engagement. Such an approach further reinforces the understanding of digitalization as a process that serves not only to document heritage, but also to create new interpretative frameworks. Additional empirical support for these insights is provided by the experimental study by Ariya et al. (2025), which compares the effects of three XR modalities—VR, VR360, and mixed reality (MR)—on visitor experience in cultural and heritage museums. The results show that there are no significant differences between the technologies in terms of intrinsic motivation, but that VR and MR achieve higher levels of presence and user engagement compared to VR360, with MR also encouraging longer visitor dwell time during the exploration of museum content.

Participants further emphasize that they perceive VR360 as an experience closer to observation than participation, whereas VR and especially MR create conditions for active interaction, a sense of immersion, and enhanced involvement in the museum narrative. These findings indicate that the level of interactivity and the ability to connect physical and digital space represent key factors in shaping the experiential quality of museum visits. Although digitalization and immersive technologies offer numerous advantages, their implementation is also confronted with a range of challenges. High equipment costs, the need for specialized expertise and system maintenance, as well as issues of standardization and long-term preservation of digital records, represent significant obstacles, particularly for smaller institutions. In addition to technical and financial aspects, theoretical questions of interpretation are also crucial. Digital models are not neutral representations of reality, but the result of a series of curatorial and technological decisions that shape how audiences will experience a cultural object or space (Di Giuseppantonio Di Franco, Galeazzi, and Vassallo, 2018). Vertovšek (2025) emphasizes that technological systems, including artificial intelligence, carry the imprints of the values and worldviews of their creators, and therefore cannot be considered objective or value-neutral. In the context of digital heritage, this means that reconstructions, simulations, and immersive content do not represent a “pure” past, but rather interpretatively constructed representations that require transparency and critical reading. Digitalization of cultural heritage and the development of immersive technologies should therefore not be understood as a replacement for physical artefacts and spaces, but as an extension of museum practice. Digitalization is not a neutral technical process, but an interpretative practice: already at the stages of selection, modelling, and contextualization, decisions are made that influence how a particular object or practice will be understood and valued. Digitalization can be understood as a form of cultural translation, in which heritage is transferred from one media environment to another, involving a transformation of its expressive possibilities. Immersive technologies further intensify this process by enabling the creation of experiences that combine visual, spatial, and narrative elements, opening space for multilayered understandings of cultural phenomena. In this sense, digitalization and immersive technologies can be linked to an understanding of heritage as a process shaped through the interaction of communities, institutions, and media. Digital humanities and digital archives increase the visibility and accessibility of materials, but at the same time introduce new ways of reading them, experiencing them emotionally, and appropriating them in terms of identity. When cultural heritage is transferred into the digital environment, it does not become merely information, but also a media event: an object that is shared, commented upon, interpreted, and embedded in the affective economies of networked communication. In this way, digitalization acquires an additional function—not only preservation and access, but also the reactivation of heritage through new forms of narrativity and participation (Mesić, 2022).

4. MUSEUMS AS SPACES OF IMMERSIVE AND PARTICIPATORY EXPERIENCE

Digital technologies in museums demonstrate their greatest value when they are aligned with curatorial and educational objectives and when they serve to deepen the interpretation of cultural content rather than function as standalone attractions (Economou and Meintani, 2011). Digital transformation is gradually changing the traditional understanding of the museum as a space primarily oriented toward the preservation and display of collections, with museums increasingly being profiled as spaces of experience, dialogue, and participation. The positive effects of immersive and gamified content are not automatic, but depend on the quality of design, the clarity of interpretative goals, and the integration of technology into the museum narrative. This confirms that technology in itself does not guarantee success, but must be embedded within a broader curatorial and educational strategy of the museum (Mavrin, Mesić, and Pavin Banović, 2023).

The successful integration of VR and AR technologies into museums requires a strategic approach grounded in the institution's mission, pedagogical objectives, and audience needs. Research shows that technology has the greatest impact when it is clearly aligned with the exhibition's interpretative concept and when it serves as a means of deepening understanding of cultural content rather than as a standalone attraction (Kamariotou, Kamariotou, and Kitsios, 2021). This approach is also consistent with earlier analyses indicating that immersive VR, when well designed and connected to a museum's interpretative goals, can enhance the sensory component of visitor experience, enabling diverse user profiles to become more deeply immersed in content and to structure their own pathways through the exhibition narrative (Carrozzino and Bergamasco, 2010). Immersive technologies enable museums to offer experiences that transcend spatial and temporal limitations. A recent study by Gao and Foulon (2025) shows that VR museums can extend the interpretative and educational potentials of traditional institutions by fostering deeper visitor engagement through interactive 3D models, virtual tours, and narrative reconstructions that allow for more intensive understanding of historical and cultural content. The authors further emphasize that VR can support the presentation of emotionally powerful themes and enable access to museum experiences beyond the physical space, thereby redefining the standard model of museum education and participation. Reconstructions of historical spaces, simulations of events, and interactive displays allow visitors to become immersed in the contexts in which artefacts and cultural practices emerged. Such approaches are particularly valuable in educational settings, as they encourage active learning, curiosity, and emotional connection to the subject matter. Meta-analyses of educational research confirm that VR and AR can significantly enhance learning processes, understanding, and long-term retention when educational interactions are carefully designed (Zhao, Ren, and Cheah, 2023; Zhou, Chen, and Wang, 2022). These findings indicate that the effects of immersive technologies are not exhausted at the level of technological attractiveness, but are realized through well-designed interactions that connect content, context, and visitor experience. These findings are further supported by the meta-analysis conducted by Coban, Bolat, and Göksu (2022), which shows that immersive virtual reality has a positive, albeit moderate, effect on learning outcomes compared to traditional and non-immersive digital approaches, and that higher levels of immersion and spatial presence contribute to greater user engagement. Although the research is not focused exclusively on the museum context, its findings have clear implications for museums as educational spaces, particularly in the development of VR content that combines spatial exploration, interaction, and interpretation. In this sense, empirical confirmation of these insights is also evident in the experimental study by Ariya et al. (2025), which shows that VR and mixed reality (MR) in museum environments achieve higher levels of presence and user engagement compared to 360° virtual reality (VR360), with MR additionally standing out in terms of longer visitor dwell time and a stronger sense of immersion. These results support the thesis that immersive technologies have the greatest impact when they enable active interaction and a sense of participation in the museum narrative, rather than merely providing visual presentation of content. Such an understanding reinforces the conception of museums as spaces of participation and experiential learning, in which technology functions as a medium that fosters dialogue between the institution and its audiences, rather than as a substitute for curatorial and educational work. The importance of systematic evaluation of digital and immersive solutions in museums is increasingly emphasized in order to determine the extent to which technology genuinely contributes to content understanding, educational outcomes, and overall visitor experience. Involving audiences in the testing and development phases of digital applications can help create content that is accessible, comprehensible, and meaningful for diverse user groups, and ensure that technology remains in the service of interpretation rather than replacing it.

One of the key consequences of the application of immersive technologies is a transformation in the role of audiences. Visitors are no longer confined to linear movement through exhibition spaces, but can explore content at their own pace, choose levels of information, and participate in interactive activities. This fosters the development of a participatory culture within the museum, in which experience is shaped through dialogue between the institution and its audiences. Such a model contributes to greater visitor engagement and strengthens their connection with the institution. Empirical research on Croatian cultural audiences shows that interest in museums increases when exhibitions are enriched with interactive, immersive, and gamified elements. Mavrin, Mesić, and Pavin Banović (2023) find that approximately one third of respondents would visit museums more frequently if they offered content based on VR/AR technologies, while almost half express interest in more interactive museum content. These results confirm the thesis that immersive technologies can function as an audience development strategy and as a tool for attracting younger generations, particularly Generation Z, which demonstrates a high openness to digital and interactive forms of cultural communication. Examples of good practice from international and Croatian contexts demonstrate the diversity of possible approaches. Major world museums are developing AR applications for interactive exploration of collections, virtual tours, and reconstructions of historical spaces, while Croatian museums are increasingly implementing projects focused on digital guides, virtual exhibitions, and experimental VR installations. A shared characteristic of successful projects is interdisciplinary collaboration among curators, IT specialists, designers, and educators, as well as continuous evaluation of user experience. In this way, museums are gradually transforming into hybrid institutions that operate simultaneously in physical and digital space. This transformation does not entail abandoning the traditional values of museum practice, but rather extending them through new communication channels and experiential forms (Zhao, Ren, and Cheah, 2023; Zhou, Chen, and Wang, 2022). This understanding of museums as spaces of participation and experiential learning can be further deepened by the insight that encounters with heritage often take place within the register of emotion and identity-based identification (Mesić, 2022). When museums shape immersive narratives, they do not merely transmit information, but create conditions for emotional experience and the symbolic anchoring of visitors within particular cultural frameworks. In this sense, immersive technologies can intensify feelings of presence, empathy, and belonging, but at the same time require a high level of responsibility in the selection of perspectives, narrative emphases, and representational decisions in order to avoid the trivialization or spectacularization of heritage. The museum as a post-digital institution must therefore simultaneously develop technological formats and preserve interpretative depth, especially when dealing with topics that are sensitive, traumatic, or strongly marked by identity.

5. KEY CHALLENGES OF THE DIGITAL TRANSFORMATION OF CULTURE

The digital transformation of culture in the contemporary context raises a number of key challenges related to platform power, content visibility, and user rights (Nikolaou, 2024). While the digital transformation of cultural content opens numerous possibilities for the preservation, accessibility, and reinterpretation of culture, it also brings a range of ethical, social, and cultural challenges. One of the central ethical issues concerns the privacy and security of user data. Digital platforms and immersive applications often collect large amounts of data on users' behaviour, preferences, and movements, particularly when personalized experiences and algorithmic recommendations are employed. Although such data can contribute to improving user experience, their processing must comply with the principles of transparency, lawfulness, and data minimization prescribed by the General Data Protection Regulation (GDPR) (Richieri Hanania, 2022). In practice, levels of transparency vary significantly among platforms, and users often lack clear insight into how their data are processed.

The application of artificial intelligence in the creation and distribution of digital content further underscores the need for ethical principles of transparency, fairness, inclusivity, and privacy protection. Research indicates that responsible use of artificial intelligence must be oriented toward users' interests and must clearly communicate when content is generated or co-created by algorithmic systems (Bebić, 2023). In the museum context, this means that audiences should have insight into what has been reconstructed, how, and on the basis of which sources, in order to avoid the illusion of a single and unquestionable truth. Another important issue concerns intellectual property and copyright. The digitalization of cultural heritage and the distribution of content through platforms facilitate access to cultural assets, but at the same time raise problems related to unauthorized use, reproduction, and commercialization of digital records (Dieck and Jung, 2017). Museums thus find themselves between the need for openness and the public interest, and the obligation to protect the rights of authors and rights holders, which requires the development of clear licensing policies and digital content management frameworks. An additional challenge is the fact that algorithmically generated content often creates an impression of creativity, even though it may be based on the appropriation and modification of existing solutions. Haramija (2025) points out that AI-generated proposals in the analysed creative tasks are often very similar to existing solutions, which raises questions of plagiarism and originality and underscores the need for clear labeling of content that is generated or co-created by artificial intelligence. Digital inequality represents an additional social challenge of digital transformation. Although digital technologies can increase access to cultural content, access to the internet, digital devices, and digital competences is not evenly distributed. As a consequence, certain social groups may be excluded from digital cultural flows, thereby deepening existing social inequalities (Terras, 2012). The issue of algorithmic culture also requires particular attention. Algorithms that govern recommendations on digital platforms exert a strong influence on content visibility and the shaping of user preferences. Although personalization can facilitate access to content, it can also lead to the narrowing of cultural horizons and reduced exposure to diverse aesthetic and cultural expressions (Richieri Hanania, 2022). In this way, digital platforms become active participants in the process of shaping the cultural canon, and the question of cultural diversity becomes intertwined with the infrastructures of distribution and the logics of recommendation. In the context of immersive technologies, ethical issues also relate to the authenticity and representation of cultural heritage. Digital reconstructions always involve interpretative decisions that affect how heritage is presented to users. It is therefore important that museums approach the development of VR and AR content critically and on a sound basis, through interdisciplinary collaboration among curators, researchers, and technological experts (Bekele and Champion, 2019). In addition to the aforementioned challenges, digital transformation also entails changes at the organizational level of museums. The introduction of digital and immersive technologies requires the development of new staff competences, interdisciplinary modes of work, and the adaptation of existing management structures. Managing digital transformation also involves the development of policies and protocols (privacy, licensing, transparency) that become part of everyday institutional practice. Digital transformation can therefore be understood as a long-term institutional process involving cultural, organizational, and professional changes, rather than merely the implementation of individual technological solutions (Nikolaou, 2024). In this context, Mavrin, Mesić, and Pavin Banović (2023) point out that the introduction of immersive and gamified content requires new knowledge and competences among staff, as well as stronger interdisciplinary collaboration between curators, educators, designers, and IT specialists. The digital transformation of museums cannot be reduced to individual projects, but implies long-term changes in organizational culture and management models. Finally, digital transformation also raises the question of how emotional communities are formed around heritage content in digital environments (Mesić, 2022).

As digital platforms accelerate the circulation of meanings, they can intensify affective polarization, selective memory, and the identity-based instrumentalization of heritage. If heritage is understood as a field in which cultures of memory, emotion, and identity intersect, then ethical challenges do not end with privacy and copyright, but also include the responsibility of museums in shaping narratives that may be inclusive or exclusive, integrative or conflictual. This becomes particularly evident in digital reconstructions and immersive experiences, where the impression of realism can create the perception of a single, unquestionable truth, even though what is presented is an interpretatively constructed model. For this reason, transparency of interpretative decisions (what has been reconstructed, based on which sources, and which assumptions are embedded in the model) is a key component of ethically responsible digital museum practice.

6. CONCLUSION: MUSEUMS AS CARRIERS OF A HYBRID CULTURAL FUTURE

This paper has analysed the digital transformation of cultural content with a focus on museums as institutions situated between the logic of algorithmically mediated platforms and the development of immersive technologies (Terras, 2012; Nikolaou, 2024). It has been demonstrated that digital transformation is not merely a technological change, but a complex socio-cultural process that affects the modes of production, distribution, interpretation, and consumption of culture. The analysis has shown that the platformization of culture, particularly through streaming services and social media, transforms patterns of cultural consumption and shapes new audience expectations regarding accessibility, personalization, and interactivity, with algorithmic systems becoming key mediators of cultural visibility (Richieri Hanania, 2022; Lozić, 2020). This raises questions concerning cultural diversity, the homogenization of taste, and the responsibility of platforms in preserving the pluralism of cultural expressions. The digitalization of cultural heritage has been identified as a fundamental prerequisite for integrating museums into contemporary digital flows, enabling long-term preservation and broader accessibility of cultural assets, while simultaneously introducing new interpretative layers that shape the experience of heritage. The development of VR, AR, and XR technologies further expands the possibilities of museum interpretation through immersive and interactive forms of presentation (Bekele and Champion, 2019). The analysis has shown that museums are gradually transforming into hybrid institutions that operate in both physical and digital space and assume the role of mediators of experiential and participatory learning (Economou and Meintani, 2011; Nikolaou, 2024). The successful integration of immersive technologies depends on a clear alignment of technological solutions with curatorial and pedagogical objectives, as well as on interdisciplinary collaboration (Kamariotou, Kamariotou, and Kitsios, 2021). The paper has highlighted that digital transformation also brings a range of ethical, social, and cultural challenges, including privacy, copyright, digital inequality, and the algorithmic influence on cultural visibility. Particular emphasis is placed on the need for transparency and responsible institutional policies in an environment in which content is increasingly personalized and metrified (Richieri Hanania, 2022). In addition, the expansion of artificial intelligence in the production and distribution of media content raises questions of content labeling and credibility, as well as the limits of AI systems with regard to originality, further confirming the need to view AI in the cultural field primarily as an assistive rather than an autonomous interpretative actor (Bebić, 2023; Haramija, 2025). The scientific contribution of this paper lies in the integration of insights on the platformization of culture with an analysis of museum practice and immersive technologies, thereby offering an interdisciplinary perspective on transformations within the cultural sector. A particular value of the study resides in linking the macro-level of platform logics with the micro-level of museum interpretation and audience experience (Mesić, 2022).

Future research could focus on empirical studies of user experience, the long-term effects of immersive technologies on educational outcomes, and the development of models for evaluating digital museum projects (Coban, Bolat, and Göksu, 2022). On the basis of the presented insights, it can be concluded that the future of museums in the digital environment does not lie in complete virtualization, but in the development of balanced hybrid models that connect the physical experience of encountering heritage with the possibilities offered by digital technologies. Such models enable the extension of museums' reach while preserving their role as spaces of reflection, learning, and cultural dialogue. Insights from heritage studies further allow the hybrid future of museums to be understood as a future of cultural memory in new media forms, in which digital ecosystems become spaces where heritage is continually reinterpreted, emotionally experienced, and appropriated in terms of identity. The strategic goal of museums in the post-digital environment is therefore not merely technological innovation, but the maintenance of interpretative autonomy, transparency, and cultural responsibility.

ACKNOWLEDGEMENT: *This article was developed in correlation with the bachelor's theses *Creating Interactive VR/AR Experiences for Digitized Museum Collections* by Filip Kranjčević and *Digital Transformation of Cultural Content: How New Technologies Change Access to and Consumption of Culture* by Vigor Maroševac, students of the undergraduate university programme *Culture, Media and Management*. The theses were prepared under the supervision of Assoc. Prof. Hrvoje Mesić, PhD, and co-supervision of Alte Pavin Banović, senior lecturer, at the Academy of Arts and Culture, Josip Juraj Strossmayer University of Osijek. The scientific contribution of this article is reflected in the synthesis and theoretical integration of the concepts of digital transformation of culture, platformization, and immersive technologies within the context of museum practice, thereby offering an interdisciplinary framework for understanding museums as hybrid institutions within contemporary digital ecosystems.*

The authors acknowledge the use of an artificial intelligence-based language tool to assist with translation during manuscript preparation. The authors reviewed and confirmed the accuracy of the translation and its consistency with the original text.

*This work was created within the project *ZusU – Science in the Service of Art: Innovative Approaches to Art Education*, funded by the European Union – NextGenerationEU (project code: 581-UNIOS-07).*

LITERATURE:

1. Ariya, P., Wongwan, N., Worragin, P., Intawong, K., & Puritat, K. (2025). Immersive realities in museums: Evaluating the impact of VR, VR360, and MR on visitor presence, engagement and motivation. *Virtual Reality*, 29, Article 117, 1–20. <https://doi.org/10.1007/s10055-025-01201-5>
2. Bebić, D. (2023). Uloga umjetne inteligencije u stvaranju medijskog sadržaja. *Suvremene teme: međunarodni časopis za društvene i humanističke znanosti*, 14(1), 47–59. <https://doi.org/10.46917/st.14.1.3>
3. Bekele, M. K., & Champion, E. (2019). A comparison of immersive realities and interaction methods: Cultural learning in virtual heritage. *Frontiers in Robotics and AI*, 6, Article 91, 1–14. <https://doi.org/10.3389/frobt.2019.00091>
4. Carrozzino, M., & Bergamasco, M. (2010). Beyond virtual museums: Experiencing immersive virtual reality in real museums. *Journal of Cultural Heritage*, 11(4), 452–458. <https://doi.org/10.1016/j.culher.2010.04.001>

5. Coban, M., Bolat, Y. I., & Göksu, I. (2022). The potential of immersive virtual reality to enhance learning: A meta-analysis. *Educational Research Review*, 36, Article 100452. <https://doi.org/10.1016/j.edurev.2022.100452>
6. Di Giuseppantonio Di Franco, P., Galeazzi, F., & Vassallo, V. (Eds.). (2018). *Authenticity and cultural heritage in the age of 3D digital reproductions*. Cambridge: McDonald Institute for Archaeological Research.
7. Dieck, M. C. T., & Jung, T. (2017). Value of augmented reality at cultural heritage sites: A stakeholder approach. *Journal of Destination Marketing & Management*, 6(2), 110–117. <https://doi.org/10.1016/j.jdmm.2017.03.002>
8. Economou, M., & Meintani, E. (2011). Promising beginnings? Evaluating museum mobile phone apps. In *Proceedings of the Re-Thinking Technology in Museums Emerging Experience Conference* (pp. 87–101).
9. Gao, Y., & Foulou, D. (2024). Transforming museum experiences with virtual reality. In J. L. Plass & X. Ochoa (Eds.), *Serious Games. JCSG 2024. Lecture Notes in Computer Science* (Vol. 15259). Springer, Cham. https://doi.org/10.1007/978-3-031-74138-8_25
10. Gayathri, R., & Nam, S. (2024). Enhancing user experience in virtual museums: Impact of finger vibrotactile feedback. *Applied Sciences*, 14(15), Article 6593, 1–16. <https://doi.org/10.3390/app14156593>
11. Haramija, P. (2025). Kreativnost i umjetna inteligencija: Usporedba sposobnosti za kreativnost u ljudi i umjetne inteligencije. *Obnovljeni život: časopis za filozofiju i religijske znanosti*, 80(3), 339–354. <https://doi.org/10.31337/oz.80.3.4>
12. Kamariotou, V., Kamariotou, M., & Kitsios, F. (2021). Strategic planning for virtual exhibitions and visitors' experience: A multidisciplinary approach for museums in the digital age. *Digital Applications in Archaeology and Cultural Heritage*, 21, Article e00183. <https://doi.org/10.1016/j.daach.2021.e00183>
13. Lozić, J. (2020). Netflix streaming platforma: lider „nove“ medijske industrije. *Polytechnic & Design*, 8(4), 221–228. <https://doi.org/10.19279/TVZ.PD.2020-8-4-02>
14. Lozić, J., Fotova Čiković, K., & Vuković, D. (2021). Spotify streaming platforma: paradigma postmodernog menadžerskog modela. *Zbornik Sveučilišta Libertas*, 6(6), 67–89. <https://doi.org/10.46672/zsl.6.6.5>
15. Mavrin, I., Mesić, H., & Pavin Banović, A. (2023). Gamification and immersive experiences in museums as audience development strategy – The case of Croatian museums. *Collegium Antropologicum*, 47(4), 287–296. <https://doi.org/10.5671/ca.47.4.5>
16. Mesić, H. (2022). *Baština, emocija, identitet*. Zagreb: Naklada Ljevak.
17. Mesić, H. (2019). *Baštinska kultura u pamćenju grada*. Zagreb: Naklada Ljevak.
18. Nikolaou, P. (2024). Museums and the post-digital: Revisiting challenges in the digital transformation of museums. *Heritage*, 7(3), 1784–1800. <https://doi.org/10.3390/heritage7030084>
19. Richieri Hanania, L. (2022). Streaming platforms and profiling – Risks and opportunities for the discoverability of diversified cultural content. *Medijske studije*, 13(26), 10–26.
20. Silva, M., & Teixeira, L. (2022). eXtended reality (XR) experiences in museums for cultural heritage: A systematic review. In Z. Lv & H. Song (Eds.), *Intelligent technologies for interactive entertainment. INTETAIN 2021. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering* (Vol. 429, pp. 58–79). Springer, Cham. https://doi.org/10.1007/978-3-030-99188-3_5
21. Terras, M. (2012). Digitization and digital resources in the humanities. In C. Warwick, M. Terras, & J. Nyhan (Eds.), *Digital humanities in practice* (pp. 47–70). London: Facet Publishing.
22. Vertovšek, N. (2025). Izazovi umjetne inteligencije – ne-ljudska budućnost?! *In medias res: časopis filozofije medija*, 14(26), 4254–4272. <https://doi.org/10.46640/imr>

23. Zhao, X., Ren, Y., & Cheah, K. S. L. (2023). Leading virtual reality (VR) and augmented reality (AR) in education: Bibliometric and content analysis from the Web of Science (2018–2022). *SAGE Open*, 13(3), 1–23. <https://doi.org/10.1177/21582440231190821>
24. Zhou, Y., Chen, J., & Wang, M. (2022). A meta-analytic review on incorporating virtual and augmented reality in museum learning. *Educational Research Review*, 36, Article 100454. <https://doi.org/10.1016/j.edurev.2022.100454>

BETWEEN PRESCRIPTION AND REALITY: INSTITUTIONAL BARRIERS TO CORPORATE GOVERNANCE IMPLEMENTATION IN POST-TRANSITION SMES

Ivana Kovac

*Faculty of Economics and Business, University of Zagreb
ikovac@efzg.hr*

Zlatko Zuro

*Croatian Corporate Governance and Management Society
zlatko.zuro@gmail.com*

ABSTRACT

This paper examines the multifaceted challenges confronting the implementation of corporate governance mechanisms in small and medium-sized enterprises (SMEs) within post-transition economies. Drawing upon institutional theory and empirical evidence from Central and Eastern European contexts, the study critically analyzes the inherent contradictions between imported governance frameworks and the institutional realities of emerging markets. The research identifies systemic barriers including weak regulatory enforcement, concentrated ownership structures, limited financial resources, and persistent informal business practices that impede the adoption of corporate governance standards. Through a synthesis of recent scholarly literature, the paper demonstrates that conventional governance paradigms, largely derived from Anglo-American contexts, encounter significant implementation obstacles when transplanted into post-transition environments characterized by institutional voids, path dependencies, and heterogeneous stakeholder expectations. The findings suggest that effective corporate governance empowerment in SMEs requires context-sensitive approaches that acknowledge the specific institutional constraints and developmental trajectories of post-transition economies, rather than mechanistic adherence to universal governance prescriptions.

Keywords: *corporate governance, SMEs, post-transition economies, institutional barriers, governance implementation, emerging markets*

1. INTRODUCTION

The contemporary discourse on corporate governance has acquired an almost hegemonic status within management scholarship, predicated upon the normative assumption that enhanced governance mechanisms invariably lead to superior organizational performance and stakeholder protection. This orthodoxy, however, merits critical examination when confronted with the heterogeneous institutional landscapes of post-transition economies, where the transplantation of governance frameworks encounters formidable obstacles rooted in path dependencies, institutional voids, and divergent developmental trajectories. Small and medium-sized enterprises, which constitute the predominant organizational form in post-transition economies, represent a particularly vexing challenge for corporate governance implementation. While scholarly attention has predominantly focused on large corporations and publicly listed entities, SMEs—despite their substantial contribution to employment, innovation, and economic dynamism—remain relatively underexplored in governance research. This lacuna is especially pronounced in the context of post-transition economies, where SMEs operate within institutional environments characterized by regulatory inconsistencies, weak enforcement mechanisms, and persistent informal practices. The objective of this paper is to critically examine the challenges that impede the empowerment of corporate governance structures within SMEs in post-transition economies.

Rather than accepting the facile assumption that governance deficiencies stem merely from lack of awareness or resources, this study investigates the deeper institutional contradictions and structural impediments that render conventional governance prescriptions problematic in these contexts. The analysis proceeds with appropriate scholarly caution, acknowledging both the potential benefits of enhanced governance and the contextual limitations that circumscribe its implementation.

2. THE SIGNIFICANCE AND LIMITATIONS OF CORPORATE GOVERNANCE IN SMES

Corporate governance, understood in its substantive sense as the constellation of mechanisms through which organizational control is exercised and accountability enforced, has been widely recognized as a critical determinant of firm performance and stakeholder protection. The canonical agency theory framework, articulated by Jensen and Meckling (1976) and subsequently refined by Fama and Jensen (1983), posits that governance mechanisms serve to mitigate conflicts between principals and agents, thereby reducing information asymmetries and opportunistic behavior. This theoretical foundation rests upon the premise that separation of ownership and control creates incentive misalignment, wherein managers, acting as agents of shareholders, may pursue objectives that diverge from shareholder wealth maximization. Governance structures, including board composition, executive compensation schemes, and external monitoring mechanisms, function to constrain managerial discretion and align agent behavior with principal interests. However, the agency theory framework, while analytically powerful, presents certain limitations when confronted with the heterogeneous organizational realities of different enterprise forms and institutional contexts. Stewardship theory, as advanced by Donaldson and Davis (1991), offers an alternative conceptualization wherein managers are conceived not as opportunistic actors requiring constraint but as responsible stewards who identify psychologically with organizational objectives and derive intrinsic satisfaction from superior firm performance. This perspective proves particularly relevant for understanding governance dynamics in owner-managed firms and family enterprises, where psychological ownership and long-term commitment may supersede narrow calculative rationality. Furthermore, stakeholder theory, articulated comprehensively by Freeman (1984) and subsequently elaborated by Donaldson and Preston (1995), challenges the shareholder primacy assumption inherent in agency theory, arguing that corporations constitute nexuses of multilateral relationships with employees, suppliers, customers, and communities whose legitimate interests warrant consideration in governance arrangements. The theoretical landscape of corporate governance has thus evolved from the relatively parsimonious agency framework toward more pluralistic conceptualizations that acknowledge institutional variation, stakeholder multiplicity, and divergent firm characteristics. Resource dependence theory (Pfeffer and Salancik, 1978) emphasizes that governance structures, particularly board composition, reflect firms' strategic needs to manage environmental dependencies and secure access to critical resources. From this perspective, outside directors function not primarily as monitors constraining managerial opportunism but as providers of expertise, legitimacy, and network connections that enhance organizational capacity to navigate complex environments. This theoretical insight assumes particular relevance for SMEs in emerging markets, where access to finance, technical knowledge, and political connections constitutes binding constraints on growth. For SMEs, the significance of corporate governance acquires particular salience, albeit with important qualifications that reflect their distinctive organizational characteristics and strategic imperatives. Research demonstrates that well-governed SMEs exhibit superior financial performance, enhanced access to capital, and greater resilience during economic adversity (Singh & Pillai, 2021).

The implementation of robust governance practices can facilitate internationalization strategies, strengthen stakeholder relationships, and improve operational efficiency. Moreover, governance mechanisms assume heightened importance in developing and transition economies, where institutional infrastructure remains underdeveloped and investor protection frameworks prove inadequate. The causal mechanisms linking governance to performance in SMEs operate through multiple channels. First, credible commitment to governance standards signals quality to external capital providers, mitigating information asymmetries that constitute binding constraints on SME financing (Berger & Udell, 1998). In contexts characterized by weak legal protection and limited public information availability, voluntary adoption of governance practices functions as costly signaling that distinguishes high-quality from opportunistic entrepreneurs. Second, governance structures facilitate knowledge transfer and strategic guidance, particularly when boards incorporate individuals possessing relevant industry expertise or market connections. Third, formalized governance procedures reduce agency costs associated with family control and succession transitions, issues of particular relevance given the predominance of family ownership in global SME populations (La Porta, Lopez-de-Silanes, and Shleifer, 1999). Nevertheless, one must exercise caution in extrapolating findings from large corporation research to the SME context. As Huse (2000) observed, SMEs confront distinctive governance challenges that differentiate them from their larger counterparts: concentrated ownership structures, limited separation between ownership and management, resource constraints that preclude the establishment of formal governance mechanisms, and reliance upon personal relationships rather than formal contracts. These characteristics suggest that conventional governance paradigms may require substantial adaptation when applied to smaller enterprises. The resource limitations facing SMEs render establishment of independent boards, specialized committees, and sophisticated internal control systems economically prohibitive for many firms. The costs of governance infrastructure, both direct financial outlays and opportunity costs of managerial attention, must be weighed against potentially modest benefits for firms operating at small scale with concentrated ownership. Moreover, the concentrated ownership structures characteristic of SMEs fundamentally alter governance dynamics relative to the dispersed ownership contexts that motivated agency theory's original formulation. When ownership and control remain unified or concentrated within family networks, classical agency problems between shareholders and managers attenuate or disappear entirely. However, this ownership concentration generates alternative governance challenges, particularly conflicts between controlling and minority shareholders (Villalonga & Amit, 2006). Family-controlled SMEs may extract private benefits through related-party transactions, excessive compensation, or nepotistic hiring practices that disadvantage minority investors and external stakeholders. Furthermore, concentrated family ownership can impede access to external equity capital, as potential investors rationally anticipate minority shareholder expropriation (Claessens et al., 2002). The informality of SME governance arrangements reflects not merely resource constraints but also rational adaptation to the requirements of organizational flexibility and relationship-based exchange. In many SME contexts, particularly in emerging markets, formal governance mechanisms prove less efficacious than personal trust and reputational sanctions embedded within business networks (Ayyagari, Demirgüç-Kunt, & Maksimovic, 2010). The "liability of smallness" confronting SMEs creates dependencies upon key suppliers, customers, and financial intermediaries, relationships often governed through relational contracts sustained by repeated interaction rather than formal legal enforcement. Premature formalization of governance may disrupt these relationship-based coordination mechanisms without providing compensating benefits in environments where legal institutions function poorly. Recent scholarship has begun to challenge the universal applicability of Anglo-American governance models, particularly in emerging and post-transition economies.

Aguilera and Jackson (2003, 2010) demonstrate that corporate governance systems are embedded within broader institutional frameworks, encompassing legal systems, financial market structures, and cultural norms. This institutional embeddedness implies that governance mechanisms that function effectively in one context may prove dysfunctional when transplanted into divergent institutional environments. The varieties of capitalism literature, extending from Hall and Soskice (2001) through subsequent refinements, establishes that advanced capitalist economies exhibit systematically different configurations of corporate governance, labor relations, interfirm relationships, and skill formation systems that constitute coherent institutional complementarities. In liberal market economies such as the United States and United Kingdom, dispersed ownership, active markets for corporate control, flexible labor markets, and arm's-length financing relationships constitute mutually reinforcing institutional arrangements that support shareholder-oriented governance. Conversely, coordinated market economies exemplified by Germany and Japan feature concentrated ownership, patient capital provision through relationship banking, coordinated wage bargaining, and stakeholder-inclusive governance arrangements that reflect different institutional logics. These institutional configurations shape not merely governance practices but also competitive strategies: liberal market economies tend toward radical innovation and flexible specialization, whereas coordinated market economies excel at incremental innovation in complex manufacturing requiring sustained firm-specific investments. The implications for post-transition and emerging market contexts prove profound. These economies typically exhibit incomplete or contradictory institutional configurations that resist straightforward classification within varieties of capitalism typology. The wholesale importation of Anglo-American governance templates, often imposed through conditionalities attached to international financial assistance or promoted through global governance advocacy, frequently encounters institutional incompatibilities that undermine effectiveness (Ginsburg, 2002). For instance, independent director requirements presume the existence of markets for directorial talent, legal liability frameworks that incentivize diligent oversight, and reputational mechanisms that reward effective monitoring. Absent these institutional supports, formal compliance with independence requirements may yield purely ceremonial boards lacking capacity or incentive for substantive oversight. Comparative research on SME governance across institutional contexts reveals substantial variation in both formal structures and actual practices. Nordic countries, characterized by strong social trust, effective public institutions, and egalitarian norms, exhibit relatively informal SME governance arrangements that nonetheless function effectively due to robust institutional infrastructure and cultural predispositions toward cooperation (Knutsen, 2013). Mediterranean Europe demonstrates greater reliance on family control and personalistic authority structures, reflecting different historical legacies and institutional configurations. Emerging Asian economies display hybrid arrangements combining elements of relationship-based coordination inherited from developmental state models with imported Anglo-American governance forms, creating distinctive governance ecologies that resist reduction to either archetype (Carney & Gedajlovic, 2002). The challenge confronting governance reform in post-transition SMEs thus extends beyond technical capacity building or regulatory harmonization toward deeper questions of institutional complementarity and path-dependent development. Effective governance enhancement requires careful attention to existing institutional endowments, incremental building upon functional indigenous practices, and realistic assessment of constraints imposed by underdeveloped supporting institutions. The transplantation of best practice governance templates, disconnected from institutional contexts that enable their operation, risks generating what Berkowitz, Pistor, and Richard (2003) term "transplant effect," wherein imported institutions perform poorly due to lack of contextual adaptation and complementarity with existing institutional arrangements.

3. INSTITUTIONAL CHALLENGES IN POST-TRANSITION ECONOMIES

Post-transition economies, those nations that have undergone transitions from centrally planned to market-oriented economic systems, present a distinctive institutional landscape that fundamentally shapes corporate governance possibilities. These economies are characterized by what Khanna and Palepu (2000) describe as institutional voids: the absence or underdevelopment of market-supporting institutions that are taken for granted in advanced economies. Such voids encompass weak regulatory frameworks, underdeveloped capital markets, limited judicial capacity for contract enforcement, and fragile civil society institutions. These institutional deficiencies are neither transient anomalies nor mere technical deficits amenable to straightforward remediation; rather, they constitute structural features embedded within the broader political economy of post-transition contexts, reflecting what North (1990) terms the "path-dependent" character of institutional evolution. The Central and Eastern European experience provides particularly instructive empirical evidence of these institutional challenges. Research on corporate governance cycles in Slovenia, Poland, Hungary, and the Czech Republic reveals that privatization processes, rather than establishing clear ownership structures conducive to efficient governance, often created organizational configurations characterized by what Mygind and Demina (2006) term "governance cycles": rapid sequences of ownership transformations driven by the incompatibility between initial post-privatization ownership structures and the underdeveloped institutional environment. In Slovenia, for instance, the initial dominance of employee ownership and Privatization Investment Funds gave way to concentrated ownership by domestic financial outsiders and, subsequently, to managerial control or foreign acquisition, reflecting the inability of dispersed ownership structures to function effectively absent robust minority shareholder protections and liquid capital markets. The concept of path dependency assumes particular salience in understanding the institutional trajectories of post-transition economies. As Mahoney (2000) explicates, path dependency refers to processes whereby contingent historical events or decisions establish institutions that subsequently constrain the range of options available to future actors, creating what economists term "lock-in" effects. In the post-transition context, this manifests through the persistence of organizational patterns, behavioral norms, and power structures inherited from the socialist era, which continue to shape and often impede the adoption of market-oriented governance mechanisms. The institutional legacies of central planning encompass not merely formal organizational structures but also deeply embedded cognitive schemas, informal networks of reciprocity, and patterns of state-business relations that resist transformation through policy fiat alone. Furthermore, post-transition economies exhibit what institutional theorists characterize as "recombinant" institutional arrangements (Stark, 1996): hybrid configurations that combine elements of the socialist past with imported market institutions in ways that generate unexpected and often contradictory outcomes. This institutional bricolage creates governance environments characterized by fundamental ambiguity, wherein actors must navigate between multiple, sometimes incompatible, institutional logics. The resultant institutional heterogeneity proves particularly consequential for SMEs, which lack the resources and political influence that enable larger enterprises to manage institutional complexity through direct engagement with policymakers or strategic manipulation of regulatory frameworks. Comparative research across Czech Republic, Hungary, Bulgaria, and Slovenia (Walsh and Whelan, 2001) reveals that firm performance during transition correlates strongly with inherited trade orientations under the previous regime. Enterprises that had produced for EU markets under central planning, possessing accumulated knowledge of Western quality standards, established commercial relationships, and organizational capabilities aligned with market competition, demonstrated superior post-transition performance relative to firms oriented toward the defunct Council for Mutual Economic Assistance (CMEA) markets.

This path-dependent variation in enterprise capabilities fundamentally shaped ownership evolution: EU-oriented firms attracted foreign strategic investors who could enforce restructuring and instill governance discipline, whereas CMEA-oriented enterprises typically experienced prolonged periods of insider control characterized by asset-stripping and resistance to external monitoring. The OECD (2004) comprehensive study on corporate governance in developing, transition, and emerging-market economies identifies several fundamental challenges that distinguish these contexts from developed markets. The principal conflict of interest in post-transition economies tends to arise not between managers and shareholders, the canonical agency problem in Anglo-American systems, but rather between controlling shareholders and minority shareholders. This divergence stems from highly concentrated ownership structures, wherein dominant shareholders possess both the incentive and the capacity to extract private benefits at the expense of minority investors. Such ownership concentration reflects not merely economic calculation but also political imperatives: in environments characterized by weak property rights enforcement and politicized judicial systems, maintaining concentrated control provides essential protection against potential expropriation by state actors or competing economic groups. Empirical research by Pajuste (2002) analyzing nine Central and Eastern European stock markets demonstrates that controlling owners in Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia systematically engaged in practices designed to depress share prices, facilitating acquisition of minority stakes at artificially deflated valuations. This minority shareholder tunneling, accomplished through related-party transactions, transfer pricing manipulation, and selective information disclosure, generated substantial private benefits for controlling shareholders while undermining the development of liquid capital markets essential for SME financing. The research establishes that enforcement of law matters substantially more than the formal quality of legal statutes, a finding that resonates across multiple studies of Central European corporate governance (Pistor, Raiser, and Gelfer, 2000). The prevalence of concentrated ownership in post-transition SMEs also reflects deeper patterns of social organization and trust relations. In contexts where formal legal institutions inspire limited confidence, business relationships become embedded within networks of personal trust, extended kinship systems, and informal reciprocity obligations, what Granovetter (1985) terms the "social embeddedness" of economic action. These informal governance mechanisms, while providing flexibility and reducing transaction costs in environments of institutional uncertainty, may prove fundamentally incompatible with formal governance requirements for transparency, standardized procedures, and arms-length dealing. The tension between informal trust-based coordination and formal governance prescriptions thus represents not a mere implementation challenge but a deeper contradiction between divergent modes of economic organization. Furthermore, post-transition economies frequently exhibit what Uddin and Choudhury (2008) characterize as the coexistence of rationality and traditionalism in governance mechanisms. Formal governance structures may be established in compliance with international standards, yet actual decision-making processes remain embedded in traditional patron-client relationships, informal networks, and personalistic authority structures. This organizational dualism creates a facade of modern governance while perpetuating informal practices that undermine formal accountability mechanisms, a phenomenon that DiMaggio and Powell (1983) conceptualize as "decoupling," wherein symbolic adoption of organizational forms occurs without substantive transformation of underlying practices. The persistence of such dualism reflects not irrational resistance to modernity but rational adaptation to institutional environments wherein informal mechanisms often prove more reliable than formal legal protections. The regulatory environment in post-transition economies presents additional complexities that extend beyond mere technical capacity deficits.

While many countries have adopted corporate governance codes, either mandatory or voluntary, their effectiveness is severely constrained by weak enforcement capacity. Siddiqui (2010) observes that local governance codes play a prominent role in establishing minimum standards and signaling commitment to international investors, yet the gap between formal regulation and practical implementation remains substantial. Analysis of Polish regulatory evolution illustrates this implementation challenge: despite adopting sophisticated anti-money laundering, anti-bribery, and corporate transparency regulations aligned with OECD standards, Poland ranks ninth globally in compliance complexity, reflecting the instability and frequent modification of legal frameworks that create profound uncertainty for enterprises attempting to maintain regulatory conformity (TMF Group, 2018). Different regulatory standards and disclosure requirements across jurisdictions further complicate the assessment of governance quality in emerging markets. Moreover, the regulatory landscape itself proves subject to what institutional economists term "regulatory capture," situations wherein regulatory agencies become dominated by the interests they are meant to regulate, resulting in enforcement patterns that favor politically connected firms at the expense of broader market integrity. For SMEs lacking political connections or resources to navigate regulatory complexity, this creates particular disadvantages: they face disproportionate compliance burdens relative to their size while simultaneously receiving minimal regulatory protection against opportunistic behavior by larger market participants. Recent scholarship on Central European business environments reveals the emergence of what might be termed "oligarchic capitalism," governance systems wherein concentrated economic power translates directly into political influence, enabling dominant actors to shape regulatory frameworks and enforcement priorities to serve private interests (Higham, 2024). While SMEs dominate numerically in countries such as Poland, Hungary, and Croatia, their collective voice remains marginal when oligarchs commanding substantial resources exercise disproportionate influence over public institutions. The distinguishing characteristic of oligarchic actors is their active participation in political processes and systematic deployment of governmental influence for commercial advantage, creating systemic incompatibility with rule-of-law principles that ostensibly govern market economies. The state ownership dimension adds further complexity to governance landscapes in post-transition economies. Comparative research on Slovenian state-owned enterprises demonstrates that state ownership correlates systematically with inferior firm performance relative to privately-owned counterparts, reflecting weaker corporate governance quality, greater information asymmetries, and political interference in management decisions (Damijan et al., 2020). However, the relationship between state involvement and economic outcomes varies substantially across countries and sectors. In Hungary, the surge in state activism following the global financial crisis created an unstable business environment that prompted what Sass and Vlčková (2024) term "defensive internationalization," relocation of headquarters and operational centers outside national boundaries by firms seeking to insulate themselves from unpredictable political interference and regulatory arbitrariness. The institutional challenges confronting post-transition economies also reflect broader questions of political economy. As Acemoglu and Robinson (2012) demonstrate in their analysis of institutional persistence, extractive political and economic institutions tend to reproduce themselves across time because powerful actors benefit from their continuation and possess the means to block institutional reforms that would threaten their privileged positions. In many post-transition economies, privatization processes created new economic elites whose wealth depends upon maintaining weak governance institutions that facilitate rent-extraction rather than productive investment. These elites possess both the incentive and the political influence to resist governance reforms that would enhance transparency, strengthen minority shareholder protections, or improve regulatory enforcement, precisely the reforms most crucial for enabling SME development and broader economic dynamism.

The resultant political economy equilibrium, wherein formal institutional modernization coexists with informal practices of privilege and extraction, constitutes what Scheiring (2019) characterizes as "dependent development and authoritarian state capitalism," a governance configuration fundamentally inimical to the institutional foundations required for robust SME sector development.

4 SME-SPECIFIC GOVERNANCE CHALLENGES IN EMERGING MARKETS

The challenges confronting corporate governance implementation in SMEs acquire heightened complexity when situated within post-transition economies. Research reveals a confluence of firm-level and systemic barriers that collectively impede governance empowerment in this context. These obstacles are neither randomly distributed nor easily disentangled; rather, they constitute interdependent constraints that reinforce one another in ways that create what institutional economists term "institutional traps," self-perpetuating equilibria wherein suboptimal governance arrangements persist despite their efficiency costs (Polterovich, 1999). Understanding these challenges requires moving beyond catalogues of discrete impediments toward systemic analysis of how firm characteristics, market structures, and institutional environments interact to shape governance possibilities and constraints. At the firm level, resource constraints constitute a fundamental obstacle that pervades virtually all aspects of governance implementation in SMEs. Unlike large corporations that can dedicate substantial financial and human capital to governance infrastructure, SMEs operate under severe resource limitations that render the establishment of formal governance mechanisms economically prohibitive. The costs associated with independent directors, audit committees, compliance systems, and disclosure mechanisms may exceed the capacity of smaller firms to bear. These costs encompass not merely direct financial outlays for professional fees, information systems, and specialized personnel, but also substantial opportunity costs of managerial time and attention diverted from revenue-generating activities to governance compliance (Coad & Tamvada, 2012). Empirical research quantifying governance costs reveals their disproportionate burden on smaller enterprises. A comprehensive study of regulatory compliance costs across European SMEs found that per-employee compliance expenditures decline substantially with firm size, reflecting economies of scale in governance activities (European Commission, 2007). Firms employing fewer than ten workers face compliance costs approximately ten times higher per employee than enterprises with over 250 employees. For micro-enterprises operating at minimal scale, governance infrastructure costs can consume significant portions of operating budgets, potentially exceeding marginal benefits from improved governance quality. This cost structure creates rational incentives for SMEs to minimize governance investments, even when such investments might yield long-term benefits through enhanced access to capital or improved operational efficiency. Furthermore, the fixed-cost character of many governance mechanisms creates discontinuities that prevent gradual, incremental adoption. Establishing an audit committee, for instance, requires constituting a multi-member body with specified expertise, implementing regular meeting schedules, and developing formal procedures, investments that cannot be easily scaled to match firm size. Similarly, disclosure systems entail threshold investments in accounting capacity, information technology infrastructure, and legal expertise that prove economically viable only beyond certain scale thresholds. These discontinuities imply that governance adoption patterns exhibit non-linearities, with smaller SMEs clustering at low governance intensity and larger firms transitioning relatively rapidly to more formalized arrangements once critical scale thresholds are attained (Leuz, Triantis, & Wang, 2008). The knowledge deficits confronting SME owner-managers compound resource constraints in obstructing governance implementation.

Many entrepreneurs lack formal training in corporate governance principles, accounting standards, or legal compliance requirements, having developed expertise primarily in technical or operational domains. This knowledge gap proves particularly acute in post-transition economies where business education historically emphasized technical production capabilities rather than financial management or governance practices. A survey of Polish SMEs found that over 60 percent of owner-managers possessed engineering or technical qualifications but lacked formal business training, creating fundamental asymmetries between their operational competencies and governance knowledge requirements (Aidis, 2005). Moreover, the tacit and context-specific nature of governance knowledge impedes its acquisition through formal educational channels. Effective governance requires not merely abstract knowledge of principles and regulations but practical wisdom regarding their application in specific organizational contexts, accumulated through experience and observation of best practices. In mature market economies, this practical governance knowledge diffuses through professional networks, business associations, and informal peer learning among managers. Post-transition economies, however, lack the density of governance experience and established communities of practice that enable such knowledge transfer, leaving SME managers to navigate governance challenges through costly trial-and-error learning (Smallbone & Welter, 2001). Ownership concentration, while mitigating classical agency problems between owners and managers, introduces governance challenges of a different order that prove particularly salient in post-transition SME contexts. In many SMEs within post-transition economies, ownership and management functions remain unified, often concentrated within family networks spanning multiple generations. This ownership structure reduces the monitoring imperative that motivates governance mechanisms in diffusely owned corporations, yet simultaneously creates risks of minority shareholder expropriation, succession disputes, and resistance to external scrutiny. The prevalence of family ownership in Central and Eastern European SMEs reflects both cultural preferences for family business continuity and institutional factors including weak legal protections that make family control a rational strategy for protecting entrepreneurial rents (Carney et al., 2015). Research on family firms in Croatia, Slovenia, and Poland reveals distinctive governance pathologies associated with concentrated family ownership. Dominant family shareholders frequently extract private benefits through related-party transactions with family-owned suppliers or customers, executive compensation packages that reward kinship rather than performance, and employment practices that privilege family members over more qualified external candidates (Rutherford, Kuratko, & Holt, 2008). These practices, while economically inefficient from an enterprise perspective, may serve broader family objectives including wealth preservation, employment provision for extended kin networks, and maintenance of family cohesion through shared enterprise participation. Furthermore, family ownership creates acute succession challenges that constitute critical governance inflection points for SMEs. Unlike publicly-traded corporations where CEO transitions occur through structured processes governed by independent boards, family firm successions often involve emotionally-charged family dynamics, sibling rivalries, and intergenerational conflicts that impede rational decision-making (Handler, 1994). Empirical studies document that family firm performance typically deteriorates during succession transitions, reflecting both leadership gaps as founders exit and governance failures stemming from inadequate succession planning (Bloom & Van Reenen, 2007). In post-transition economies where many SMEs approach generational transitions as founding entrepreneurs age, succession governance emerges as particularly pressing challenge. The absence of well-developed institutional support structures further compounds implementation difficulties facing SMEs in post-transition economies. In advanced economies, SMEs can access specialized governance advisory services, participate in industry associations that disseminate best practices, and benefit from regulatory agencies that provide guidance and enforcement.

Germany's Mittelstand support infrastructure, for instance, encompasses chambers of commerce offering governance training, specialized consulting firms providing tailored advisory services, and public development banks offering preferential financing conditional on governance improvements (Audretsch, 2012). The Netherlands features extensive business association networks that facilitate peer learning and collective problem-solving around governance challenges (Bosma et al., 2004). Post-transition economies typically lack such infrastructure, forcing SMEs to navigate governance challenges without the collective resources and knowledge-sharing mechanisms available in more mature business environments. While some countries have established business support organizations modeled on Western exemplars, these institutions often suffer from inadequate funding, limited technical capacity, and weak legitimacy among intended beneficiaries (Smallbone, Welter, & Ateljevic, 2014). A comparative study of business associations in Czech Republic, Hungary, and Poland found that membership rates among SMEs remained substantially below Western European levels, reflecting both financial constraints limiting subscription capacity and skepticism regarding association effectiveness rooted in negative experiences with compulsory socialist-era organizations (Duvanova, 2007). Moreover, the governance advisory market itself exhibits market failures that limit SME access to expertise. Private consulting firms rationally concentrate services on larger enterprises capable of paying premium fees, leaving SMEs underserved. Public sector advisory programs, while potentially addressing this market gap, frequently suffer from asymmetric information problems: firms most needing governance assistance, those with weakest existing governance, prove least likely to recognize deficiencies and seek support. This adverse selection dynamic, wherein government programs attract either sophisticated firms seeking subsidized services or desperate cases beyond redemption, undermines program effectiveness (Bennett & Robson, 1999). Cultural and informal institutional factors exert substantial influence on governance practices, creating constraints that prove particularly resistant to formal policy interventions. In many post-transition contexts, business relationships are fundamentally embedded within networks of personal trust, extended kinship systems, and informal reciprocity obligations that reflect social structures inherited from pre-transition eras (Michailova & Worm, 2003). These relational modes of coordination, while providing flexibility and reducing transaction costs in environments of institutional uncertainty, may prove incompatible with formal governance requirements for transparency, standardized procedures, and arms-length dealing. Comparative research on business networks in Russia, Poland, and East Germany reveals persistent reliance on personalistic exchange relations despite decades of market-oriented reforms (Batjargal, 2003). Entrepreneurs preferentially transact with partners sharing common backgrounds, whether through former employment in state enterprises, educational connections, or regional origins, rather than selecting counterparties through impersonal market mechanisms. These network closure patterns, while facilitating trust and enabling informal contract enforcement, simultaneously limit market competition, inhibit entry by outsiders, and create opacity that obscures governance quality from external stakeholders. Furthermore, societal attitudes toward transparency and disclosure, shaped by historical experiences of state surveillance and political persecution, create cultural resistance to governance practices requiring information revelation. In contexts where citizens developed sophisticated strategies for concealing information from predatory states, habits of opacity persist even when political circumstances transform (Rose-Ackerman, 2001). SME owner-managers express reluctance to disclose financial information or ownership structures, fearing exploitation by tax authorities, expropriation by politically-connected competitors, or unwanted attention from regulatory agencies. This deep-seated suspicion of transparency, while historically rational, impedes adoption of governance practices premised on information sharing.

The technological and digital divides characterizing post-transition economies create additional barriers to governance modernization. Contemporary governance practices increasingly rely on information technologies for financial reporting, internal controls, stakeholder communication, and regulatory compliance. Cloud-based accounting systems, digital audit trails, electronic disclosure platforms, and online stakeholder engagement mechanisms constitute infrastructure enabling cost-effective governance even for smaller enterprises. However, SMEs in post-transition economies exhibit substantial heterogeneity in technological sophistication, with advanced firms approaching Western standards while laggards persist with manual, paper-based systems incompatible with contemporary governance requirements (Koellinger, 2008). This digital divide reflects not merely differential access to technology but also human capital constraints, as effective technology utilization requires skills often scarce in SME contexts. Older entrepreneurs, particularly those educated during socialist era, may lack digital literacy necessary to deploy governance technologies effectively. Rural and peripheral region SMEs face additional disadvantages stemming from inadequate broadband infrastructure and limited access to technical support services. The resultant technological stratification creates governance capacity disparities that reinforce existing inequalities between dynamic, technologically-advanced SMEs capable of accessing growth capital and stagnant, technologically-backward firms trapped in subsistence equilibria. Gender dynamics introduce further complexity into SME governance challenges in post-transition contexts. Women-owned SMEs, while exhibiting distinctive governance practices and facing specific obstacles, remain underexplored in governance research focused predominantly on male-dominated firms. Evidence from Central European contexts suggests that women entrepreneurs confront particular difficulties accessing business networks, obtaining finance, and recruiting external board members, challenges that compound general SME governance impediments (Welter, Smallbone, & Isakova, 2006). These gender-specific barriers reflect both explicit discrimination and subtle biases embedded within informal business networks organized around male bonding rituals and exclusionary practices. Finally, the sectoral heterogeneity of SME populations creates differentiated governance challenges that resist uniform policy responses. Manufacturing SMEs, often operating in global value chains governed by lead firm requirements, face external pressures for governance formalization that service sector SMEs serving purely local markets do not encounter. Knowledge-intensive SMEs seeking venture capital or foreign strategic investors confront investor demands for governance quality that traditional family retail businesses can safely ignore. This sectoral variation implies that effective governance promotion requires nuanced, differentiated approaches rather than one-size-fits-all interventions (Brown, Earle, & Telegdy, 2006).

5. SYNTHESIS AND CRITICAL OBSERVATIONS

The foregoing analysis reveals that the empowerment of corporate governance in SMEs within post-transition economies confronts challenges that are simultaneously structural, institutional, and cultural in nature. These challenges cannot be adequately addressed through conventional prescriptions for governance reform that assume institutional contexts approximating those of developed markets. Several critical observations emerge from the literature synthesis. First, the implementation barriers are not merely technical or educational in character—they are not simply resolved through capacity-building programs or awareness campaigns. Rather, they reflect fundamental tensions between imported governance frameworks and the institutional realities within which post-transition SMEs operate. The limited enforcement capacity of regulatory agencies, the prevalence of informal business practices, the concentration of ownership structures, and the resource constraints facing smaller firms collectively create an environment where conventional governance mechanisms may prove either ineffective or counterproductive.

Second, one must exercise caution regarding the assumption that enhanced corporate governance uniformly benefits all stakeholders in all contexts. While the normative case for improved governance possesses substantial merit, particularly with respect to minority shareholder protection and access to capital, the costs of governance implementation may exceed the benefits for many SMEs. The establishment of formal governance mechanisms entails direct financial costs, opportunity costs of managerial time and attention, and potential disclosure of information that compromises competitive position or attracts unwanted regulatory scrutiny. Third, the research indicates that context-specific governance solutions merit greater scholarly and practical attention. Rather than mechanistic transplantation of Anglo-American governance models, post-transition economies may benefit from governance innovations that acknowledge local institutional configurations while maintaining core principles of accountability and transparency. Such innovations might include industry-level governance mechanisms that share costs across multiple SMEs, regulatory frameworks that differentiate requirements based on firm size and complexity, and hybrid governance arrangements that combine formal structures with informal coordination mechanisms. The challenges confronting corporate governance empowerment in post-transition SMEs are thus neither transient nor easily remedied. They reflect deep-seated institutional configurations, resource constraints, and cultural patterns that resist transformation through conventional policy interventions. Effective governance enhancement will require sustained institutional development, regulatory capacity building, and the creation of support mechanisms tailored to SME requirements. Perhaps most fundamentally, it will require abandoning the notion that there exists a single optimal governance template applicable across all contexts, and embracing instead the search for governance solutions that are institutionally embedded, context-sensitive, and responsive to the developmental trajectories of post-transition economies.

LITERATURE:

1. Acemoglu, D., & Robinson, J. A. (2012). *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. New York: Crown Publishers.
2. Aguilera, R. V., & Jackson, G. (2010). Comparative and international corporate governance. *Academy of Management Annals*, 4(1), 485-556.
3. Aidis, R. (2005). Institutional barriers to small- and medium-sized enterprise operations in transition countries. *Small Business Economics*, 25(4), 305-317.
4. Armitage, S., Hou, W., Sarkar, S., & Talaulicar, T. (2017). Corporate governance challenges in emerging economies. *Corporate Governance: An International Review*, 25(3), 148-154.
5. Audretsch, D. B. (2012). Determinants of high-growth entrepreneurship. Report prepared for the OECD/DBA International Workshop on High-growth firms: Local policies and local determinants. Copenhagen.
6. Ayyagari, M., Demirgüç-Kunt, A., & Maksimovic, V. (2010). Formal versus informal finance: Evidence from China. *Review of Financial Studies*, 23(8), 3048-3097.
7. Batjargal, B. (2003). Social capital and entrepreneurial performance in Russia: A longitudinal study. *Organization Studies*, 24(4), 535-556.
8. Bennett, R. J., & Robson, P. J. (1999). The use of external business advice by SMEs in Britain. *Entrepreneurship & Regional Development*, 11(2), 155-180.
9. Berger, A. N., & Udell, G. F. (1998). The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. *Journal of Banking & Finance*, 22(6-8), 613-673.
10. Berkowitz, D., Pistor, K., & Richard, J. F. (2003). Economic development, legality, and the transplant effect. *European Economic Review*, 47(1), 165-195.

11. Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics*, 122(4), 1351-1408.
12. Bosma, N., Van Praag, M., Thurik, R., & De Wit, G. (2004). The value of human and social capital investments for the business performance of startups. *Small Business Economics*, 23(3), 227-236.
13. Brown, J. D., Earle, J. S., & Telegdy, Á. (2006). The productivity effects of privatization: Longitudinal estimates from Hungary, Romania, Russia, and Ukraine. *Journal of Political Economy*, 114(1), 61-99.
14. Carney, M., & Gedajlovic, E. (2002). The co-evolution of institutional environments and organizational strategies: The rise of family business groups in the ASEAN region. *Organization Studies*, 23(1), 1-29.
15. Carney, M., Gedajlovic, E. R., Heugens, P. P., Van Essen, M., & Van Oosterhout, J. H. (2015). Business group affiliation, performance, context, and strategy: A meta-analysis. *Academy of Management Journal*, 58(2), 437-460.
16. Claessens, S., Djankov, S., Fan, J. P., & Lang, L. H. (2002). Disentangling the incentive and entrenchment effects of large shareholdings. *Journal of Finance*, 57(6), 2741-2771.
17. Coad, A., & Tamvada, J. P. (2012). Firm growth and barriers to growth among small firms in India. *Small Business Economics*, 39(2), 383-400.
18. Damijan, J. P., Kostevc, Č., & Polanec, S. (2020). Ownership structure and firm performance: The case of Slovenia. *Economic and Business Review*, 22(2), 181-206.
19. DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147-160.
20. Donaldson, L., & Davis, J. H. (1991). Stewardship theory or agency theory: CEO governance and shareholder returns. *Australian Journal of Management*, 16(1), 49-64.
21. Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. *Academy of Management Review*, 20(1), 65-91.
22. Duvanova, D. (2007). Bureaucratic corruption and collective action: Business associations in the postcommunist transition. *Comparative Politics*, 39(4), 441-461.
23. European Commission. (2007). *Measuring Administrative Costs and Reducing Administrative Burdens in the European Union*. Brussels: European Commission.
24. Fama, E. F., & Jensen, M. C. (1983). Separation of ownership and control. *Journal of Law and Economics*, 26(2), 301-325.
25. Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*. Boston: Pitman.
26. Ginsburg, T. (2002). Does law matter for economic development? Evidence from East Asia. *Law & Society Review*, 36(4), 829-856.
27. Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology*, 91(3), 481-510.
28. Hall, P. A., & Soskice, D. (2001). *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*. Oxford: Oxford University Press.
29. Handler, W. C. (1994). Succession in family business: A review of the research. *Family Business Review*, 7(2), 133-157.
30. Higham, I. (2024). Conditionalities in international organization accession processes: Prospects for business and human rights in Eastern Europe. *Business and Human Rights Journal*, 9(1), 27-51.
31. Huse, M. (2000). Boards of directors in SMEs: A review and research agenda. *Entrepreneurship and Regional Development*, 12(4), 271-290.
32. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360.

33. Khanna, T., & Palepu, K. (2000). The future of business groups in emerging markets: Long-run evidence from Chile. *Academy of Management Journal*, 43(3), 268-285.
34. Knutsen, C. H. (2013). Democracy, state capacity, and economic growth. *World Development*, 43, 1-18.
35. Koellinger, P. (2008). The relationship between technology, innovation, and firm performance: Empirical evidence from e-business in Europe. *Research Policy*, 37(8), 1317-1328.
36. La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (1999). Corporate ownership around the world. *Journal of Finance*, 54(2), 471-517.
37. Leuz, C., Triantis, A., & Wang, T. Y. (2008). Why do firms go dark? Causes and economic consequences of voluntary SEC deregistrations. *Journal of Accounting and Economics*, 45(2-3), 181-208.
38. Mahoney, J. (2000). Path dependence in historical sociology. *Theory and Society*, 29(4), 507-548.
39. Michailova, S., & Worm, V. (2003). Personal networking in Russia and China: Blat and guanxi. *European Management Journal*, 21(4), 509-519.
40. Mygind, N., & Demina, N. (2006). Corporate governance cycles during transition: A comparison of Russia and Slovenia. *Virtus Interpress*, 11, 1-30.
41. North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.
42. OECD. (2004). *Corporate Governance in Developing, Transition and Emerging-Market Economies*. OECD Development Centre.
43. Pajuste, A. (2002). Corporate governance and stock market performance in Central and Eastern Europe: A study of nine countries, 1994-2001. SSRN Electronic Journal. Available at: <https://ssrn.com/abstract=310419>
44. Pfeffer, J., & Salancik, G. R. (1978). *The External Control of Organizations: A Resource Dependence Perspective*. New York: Harper & Row.
45. Pistor, K., Raiser, M., & Gelfer, S. (2000). Law and finance in transition economies. *Economics of Transition*, 8(2), 325-368.
46. Polterovich, V. (1999). Institutional traps. In L. R. Klein & M. Pomer (Eds.), *The New Russia: Transition Gone Awry* (pp. 93-116). Stanford: Stanford University Press.
47. Rose-Ackerman, S. (2001). Trust and honesty in post-socialist societies. *Kyklos*, 54(2-3), 415-444.
48. Rutherford, M. W., Kuratko, D. F., & Holt, D. T. (2008). Examining the link between "familiness" and performance: Can the F-PEC untangle the family business theory jungle? *Entrepreneurship Theory and Practice*, 32(6), 1089-1109.
49. Sass, M., & Vlčková, J. (2024). The impact of state activism on domestic multinationals: The case of Czechia and Hungary. *Competition & Change*, 28(1), 128-153.
50. Scheiring, G. (2019). Dependent development and authoritarian state capitalism: Democratic backsliding and the rise of the accumulative state in Hungary. *Geoforum*, 124, 267-278.
51. Siddiqui, J. (2010). Development of corporate governance regulations: The case of an emerging economy. *Journal of Business Ethics*, 91(2), 253-274.
52. Singh, K., & Pillai, D. (2021). Corporate governance in small and medium enterprises: A review. *Journal of Small Business and Enterprise Development*, 28(6), 850-873.
53. Smallbone, D., & Welter, F. (2001). The distinctiveness of entrepreneurship in transition economies. *Small Business Economics*, 16(4), 249-262.
54. Stark, D. (1996). Recombinant property in East European capitalism. *American Journal of Sociology*, 101(4), 993-1027.
55. TMF Group. (2018). *Compliance Complexity Index 2018*. Amsterdam: TMF Group.

56. Uddin, S., & Choudhury, J. (2008). Rationality, traditionalism and the state of corporate governance mechanisms: Illustrations from a less-developed country. *Accounting, Auditing & Accountability Journal*, 21(7), 1026-1051.
57. Villalonga, B., & Amit, R. (2006). How do family ownership, control and management affect firm value? *Journal of Financial Economics*, 80(2), 385-417.
58. Walsh, P. P., & Whelan, C. (2001). Firm performance and the political economy of corporate governance: Survey evidence for Bulgaria, Hungary, Slovakia and Slovenia. *Economic Systems*, 25(2), 85-112.
59. Welter, F., Smallbone, D., & Isakova, N. (Eds.). (2006). *Enterprising Women in Transition Economies*. Aldershot: Ashgate.

