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DEVELOPMENT OF DIGITAL ENTERPRISE ECOSYSTEMS WITH THE METAVERSE POTENTIAL

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ABSTRACT
The term "metaverse" is emerging as a novel paradigm within the digital economy and digital ecosystems. This study contributes to digital immersive technology - Extended reality and Metaverse, its possibilities for the development of the digital environment and enterprise ecosystems as an important part of modern economic analysis. The purpose of current study was to examine the essence and significance of emerging immersive technologies and in particular metaverse within the paradigm of Industry 5.0. This study uses a qualitative approach with secondary data collection and analysis through desk research method. The research results show that emerging digital technologies are a driving force in the development of enterprise ecosystems. These technologies can significantly influence production processes, interactions between ecosystem actors, and the creation of added value. The practical implementation is that a particular focus is placed on the origin and evolution of the "metaverse", its applicability in enterprises and the effects of digital technologies application. The conclusion highlights the need for further research on digital technologies and the impact of metaverse to enhance their efficacy in enterprise ecosystem management in the 5.0 Era.

Keywords*:* industry 5.0, metaverse, XR, digitalization, digital ecosystem, enterprise, innovation

INTRODUCTION

The modern Society 5.0 is undergoing a period of profound transformation in the structure of business relationships. In conditions of high market instability, enterprises increasingly base their strategic advantages on partnership interaction, resource sharing, and knowledge exchange. This enables better adaptation to changing market conditions through network effects. Digital technologies have emerged as a catalyst for novel opportunities in business interaction with the external environment, thereby disrupting conventional approaches to business process organization and enhancing their flexibility and efficiency.

This study contributes to digital immersive technology - Extended reality and Metaverse, its possibilities for the development of the digital environment and enterprise ecosystems as an important part of modern economic analysis. In particular focus is placed on the origin and evolution of the "metaverse", its applicability in enterprises and the effects of digital technologies application.

The purpose of this study is to examine the essence and significance of emerging immersive technologies and in particular metaverse within the paradigm of Industry 5.0. In order to achieve this goal, the research uses a qualitative approach with secondary data collection and analysis through desk research method. The research results show that emerging digital technologies are a driving force in the development of enterprise ecosystems. These technologies can significantly influence production processes, interactions between ecosystem actors, and the creation of added value.

The practical implementation is that a particular focus is placed on the origin and evolution of the "metaverse", its applicability in enterprises and the effects of digital technologies application. The conclusion highlights the need for further research on digital technologies and the impact of metaverse to enhance their efficacy in enterprise ecosystem management in the 5.0 Era.

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THE CONCEPT OF INDUSTRY 5.0 AND EMERGING TECHNOLOGY

The fifth industrial revolution, otherwise known as Industry 5.0, is marked by the evolution of production methods that extend beyond the mere provision of goods and services for financial gain. This paradigm shift entails a redefinition of the primary focus from shareholder value to stakeholder value, thereby underscoring the pivotal role and contribution of industry to the broader societal context. This paradigm prioritizes the well-being of the laborer, situating it at the core of the production process. It employs innovative technologies to foster prosperity that extends beyond mere employment and economic growth, while adhering to the planet's sustainable production limits. This initiative is a complementary addition to the prevailing "Industry 4.0" approach, with a specific focus on leveraging research and innovation to facilitate the transition to a sustainable, human-centric, and resilient European industry (1).

In this context, the extensive report "THE 2025 EDGE AI TECHNOLOGY" explores a comprehensive overview of the current and future landscape of technological advancements that underpin Edge AI, detailing its hardware, software, and real-world applications. It examines industry trends driving Edge AI adoption, highlighting its transformative role in sectors like autonomous vehicles, supply chain management, manufacturing, smart agriculture, digital healthcare and others (2).

IMMERSIVE DIGITAL TECHNOLOGY: EXTENDED REALITY (XR) AND METAVERSE

The research survey "European XR Industry Report 2025" provides a comprehensive overview of the extended reality (XR) ecosystem across Europe. It analyses industry trends, including revenue, funding, export markets, and growth expectations, drawing data from over 230 organizations, primarily small and medium-sized enterprises (SMEs). According to the report, specific terms are used in the context of the metaverse (3):

- **Virtual Reality (VR):** A simulated experience that can be similar to or completely different from the real world, typically achieved through VR headsets that provide immersive visual and auditory feedback. This technology creates a simulated environment that can be experienced visually and sometimes physically, blocking out sensory information from the real world to immerse the user in a digital reality.
- **Augmented Reality (AR):** An interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory. This technology superimposes digital information and content onto a user's view of the real world, augmenting or altering the current reality, but users are not isolated from the physical environment.
- **Mixed Reality (MR):** The merging of real and virtual worlds to produce new environments and visualisations where physical and digital objects co-exist and interact in real-time. A term often used interchangeably with XR.
- **Extended Reality (XR):** An umbrella term encompassing virtual reality (VR), augmented reality (AR), and mixed reality (MR), referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables.
- **Metaverse**: Often used interchangeably with XR, it refers to a collective virtual shared space, created by the convergence of virtually enhanced physical reality and persistent virtual spaces, providing novel forms of engrossing telepresence.

According to Xi et. al. (2023), modern information and communication technologies enable new capabilities and more efficient processes. The metaverse (i.e., extended reality, or XR) enables new forms of immersive telepresence. These technologies are facilitating work, education, healthcare, consumption, entertainment, and more (4). At the same time, the metaverse brings a number of challenges.

What really is the metaverse?

The concept of metaverse was first introduced in Neal Stephenson's 1992 science fiction novel, Snow Crash. In the novel, the characters became avatars and worked in a three-dimensional virtual reality called the Metaverse, a portmanteau of "meta" (meaning "what lies beyond") and "universe". In fact, Stephenson coined the term "metaverse" to describe a computer-generated virtual universe populated with avatars (5). Since then, movies and multiplayer online games have increasingly incorporated varying perceptions of the

metaverse. However, none of them have offered a comprehensive vision of it.

As the development of the "metaverse" remains in its nascent stages, a consensus on a shared definition of the term remains elusive. The prevailing consensus regarding the metaverse is that it is a network of immersive virtual worlds created using a range of frontier technologies to empower the increasing integration of the virtual and physical environments (6).

The metaverse is defined as a network of immersive virtual worlds, created using a range of frontier technologies to facilitate the increasing integration of the virtual and physical environments. Specifically, the term now refers to any virtual space that emphasizes creating immersive environments as part of a developing ecosystem (7). Wearing special goggles allows one to interact with the environment through an avatar and fully experience it.

According to Bosworth (2024), the convergence of AI, AR, and the metaverse will continue to push the boundaries of human-computer interaction (8). Future AR/VR systems will do more than display information; they will generate adaptive, AI-driven digital environments that respond intelligently to users. These interfaces will evolve dynamically to tailor experiences to individual preferences, work habits, and social interactions. Furthermore, the next era of mixed reality will be an active, AI-powered, hyper-personalized digital layer that adapts continuously to the world around us.

THE DIGITALIZATION AND ENTERPRISES IN THE ERA 5.0

The core mission of enterprises, like any business organizations, is to ensure sustainable profitability and increase value for owners, shareholders and society as a whole. Achieving these goals not only contributes to the financial success of the company, but also benefits a wide range of stakeholders. Stimulating competition leads to improved quality of goods and services, the government benefits through tax revenues, which helps to implement social programs. Consumers benefit by gaining access to quality and innovative products, while the scientific community and the education sector are stimulated to develop new products and train specialists (9). Mass media, in turn, contributes to maintaining openness and trust in society by creating a transparent information field. Thus, the digitalization of the enterprise ecosystem is a powerful tool that, with a systematic approach, can significantly enhance its potential and ensure sustainable development in the digital economy.

The digital transformation provides enterprises with an opportunity to fundamentally rethink all aspects of their operations, from production processes and supply chains to customer interaction and the development of new business models. The integration of different technologies and strategies into a single ecosystem creates synergies that enhance the overall effect. Thus, enterprise digitalization is not just the introduction of technology, but a comprehensive transformation process that allows enterprises to not only optimize current processes, but also prepare for future challenges, ensuring sustainable growth and competitiveness (10).

The digitalization also offers enterprises a wide potential to increase profits and optimize costs. Digital technologies can transform not only internal processes, but also interactions with customers, suppliers and stakeholders, affecting both key components of profitability. In addition, digitalization improves customer relationship management and marketing. Utilizing digital platforms and social media reduces the cost of traditional channels while increasing communication effectiveness and customer loyalty (11). On the one hand, technological innovations such as big data, artificial intelligence, automation and blockchain can increase revenues by creating new products, optimizing supply chains and personalizing customer offerings. They open access to new markets and segments, increasing growth opportunities. On the other hand, digital technologies reduce costs by automating production and administrative processes, which reduces labor and operating costs (12). Analytics tools optimize resource utilization, reducing raw material, energy and logistics costs. Digital inventory and supply chain management improves accuracy and minimizes losses.

THE POTENTIAL FOR DIGITALIZATION OF ENTERPRISE ECOSYSTEMS

In the context of digitalization and transformation of enterprises, the concept of "potential" takes on a new meaning, encompassing not only traditional capabilities, but also the prospects associated with the introduction of digital technologies. These innovations allow companies to radically improve the efficiency of production processes, optimize management and business procedures,

and create new products and services that can change the competitive environment (13).

The digitalization of the ecosystem in which an enterprise is integrated opens up access to new resources and opportunities. This process involves both quantitative and qualitative growth, leading to new ecosystem capabilities. Research works on the digitalization of enterprises emphasize that it affects all key aspects of their activities - financial, human resources, production-technological and scientific-technical potential (14).

It is important to note that fragmented digitalization of the ecosystem creates a fragmented, heterogeneous environment similar to "patchwork automation". In this case, digitalization is reduced to the automation of individual information flows between system participants, rather than to the creation of a unified digital platform. While such measures may reduce labor and transaction costs, the overall opportunities and growth potential remain limited (15). Hence, to fully unlock the potential of digitalization, systemic digital technologies that support all information flows within the ecosystem must be implemented.

The following table presents how specific digital technologies can contribute to various potential improvements in the enterprise ecosystem. **(Table 1)**

Table 1. *Types of digital innovation technologies and the effects of their application in enterprise ecosystems*

	Digital technology	Potential effect in the enterprise ecosystem
1	Artificial Intelligence (AI), machine learning (ML) and cloud technologies (CT)	- Informed decision making: AI processes large amounts of data to provide accurate predictions and analytics, helping in informed decision making; - Improving product quality: AI can analyze manufacturing processes, identifying inefficient steps and suggesting improvements; - Innovation: developing new products and services, adapting to change. - Cost reduction: saving on IT infrastructure and increasing scalability; - Security and reliability: protecting against cyber threats and ensuring data security.
2	Additive Technology (AT)	- Innovative: enable rapid prototyping and testing of new product designs; - Sustainability: reduce material waste through precision and resource conservation in manufacturing.
3	Blockchain (BC)	- Security and reliability: Protects data and transactions, eliminating fraud risks and increasing transparency; - Digital Supply Chain Integration: improves traceability and accountability, making logistics processes more efficient.
4	Internet of Things (IoT)	- Increased productivity: IoT sensors and devices provide online data for monitoring and optimizing production processes. It also enables automation of various processes and activities, such as lighting and temperature control, monitoring and control of production lines, automatic alerts in case of abnormal situations, etc.; - Predictive maintenance and product improvement: it allows predicting the need for maintenance of equipment, preventing malfunctions; - Integration with other technologies: IoT is often integrated with other technologies such as artificial intelligence, cloud computing and big data to improve data analysis and decision making.
5	Robotics (RB)	- Automation of production processes: robots increase the efficiency and speed of production by reducing labor and operation time; - Cost reduction: replacing manual labor with automated processes leads to increased resource efficiency.
6	Social Media (SM)	- Improving customer experience: allow you to interact with customers, collect feedback and offer personalized services; - Staff development and training: used for knowledge sharing and staff development; - Improving communication: allow to expand the information field both internally and with external counterparts (buyers - improved customer experience, personalized service and better interaction with customers, suppliers, labor market, etc.).
7	Virtual Reality (VR), Augmented Reality (AR) or Mixed Reality (MR)	- Training and staff development: virtual trainings and simulations help in the training of complex production processes; - Flexibility and adaptability: help visualize and simulate production processes and products, improving planning and adapting to change.

Source: Prepared by the authors of this study based on the literature review

In summary, each of these technologies contributes to a more efficient, innovative and

sustainable manufacturing ecosystem that can adapt to rapidly changing market conditions and requirements. It is also important to keep in mind that the greatest effectiveness is achieved through a holistic approach, where different digitalization tools integrate and interact with each other.

CONCLUSION

This article examines Industry 5.0, the significant shift in manufacturing that goes beyond simply generating profit to prioritizing value for stakeholders and the well-being of people within a sustainable framework. The text describes the key technologies that are facilitating this transformation, namely the Metaverse and Extended Reality (XR), which encompasses virtual, augmented, and mixed reality. The concept of the Metaverse is presented in depth, explaining it as a collective, immersive virtual space facilitated by XR and AI.

In addition, the study focuses on how digitalization is fundamentally transforming business ecosystems to increase profitability, optimize processes, and promote sustainable growth by integrating technologies such as artificial intelligence, big data, and blockchain. This highlights the importance of a unified digital approach over fragmented automation to maximize potential. Finally, the article delves into the profound impact of digitalization on business ecosystems, highlighting the potential of digitalization to increase profitability, optimize processes, and drive sustainable growth through comprehensive, rather than fragmented, technology integration.

Currently, there is no unified approach to the study of digital ecosystems, and the question of assessing their potential in enterprises as economic entities remains under-researched. This study illustrates the essence and significance of the concept of enterprise digitalization as a research topic and explains the potential of the metaverse as an ecosystem for digitalization

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REFERENCES

1. European Commission: Directorate-General for Research and Innovation. Industry 5.0: human-centric, sustainable and resilient. Publications Office, 2020 Available at: https://data.europa.eu/doi/10.2777/073781.
2. Samir, J., The 2025 Edge AI Technology Report Available at: https://www.wevolver.com/article/2025-edge-ai-technology-report/null
3. Barngrover, M., EUROPEAN XR INDUSTRY REPORT 2025. A collaborative research revealing SME insights, industry sentiments, and trends shaping XR's future in Europe for 2025 and beyond Available at: https://xr4europe.eu/wp-content/uploads/European-XR-Industry-Report-2025.pdf
4. Xi, N., Chen, J., Gama, F., Riar, M., & Hamari, J., The challenges of entering the metaverse: An experiment on the effect of extended reality on workload. *Information Systems Frontiers*, 25(2), pp. 659-680, 2023
5. Stephenson, N., Snow crash. New York: Bantam Books, 2000
6. Ng, D. T. K., What is the metaverse? Definitions, technologies and the community of inquiry. *Australasian Journal of Educational Technology*, 38(4), pp. 190-205, 2022
7. Mystakidis, S., Metaverse. *Encyclopedia*, 2(1), pp. 486-497, 2022
8. Bosworth, A., Accelerating the Future: AI, Mixed Reality and the Metaverse, Meta, 2024 Available at: https://about.fb.com/news/2024/12/accelerating-the-future-ai-mixed-reality-and-the-metaverse/
9. Aziz, A., Promising business opportunities in the industrial age 4.0 and the society era 5.0 in the new-normal period of the covid-19 pandemic. *Scholarly Journal of Psychology and Behavioral Sciences*, 2021
10. Kraus, N., Kraus, K., Manzhura, O. L. E. K. S. A. N. D. R., Ishchenko, I. N. N. A., & Radzikhovska, Y. U. L. I. I. A., Digital transformation of business processes of enterprises on the way to becoming industry 5.0 in the gig economy. *WSEAS Transactions on Business and Economics*, 93(20), pp. 1008-1029, 2023
11. Harmash, O., Hubarieva, I., Harmash, T., & Trushkina, N., Relationship between the concepts of “digital transformation” and

"industry 5.0": bibliometric analysis. *Intellectualization of logistics and Supply Chain Management*, 24, pp. 89-106, 2024

12. Lachvajderová, L., & Kádárová, J., Industry 4.0 implementation and industry 5.0 readiness in industrial enterprises. *Management and Production Engineering Review*, 13, 2022
13. Barykin, S. Y., Kapustina, I. V., Kirillova, T. V., Yadykin, V. K., & Konnikov, Y. A., Economics of digital ecosystems. *Journal of Open Innovation: Technology, Market, and Complexity*, 6(4), p. 124, 2020
14. Maiorova, K. S., & Balashova, E. S., Digital transition of industrial enterprises to" smart" ecosystem. International Research Journal, (12-4 (114)), pp. 79-86, 2021
15. Suuronen, S., Ukko, J., Eskola, R., Semken, R. S., & Rantanen, H., A systematic literature review for digital business ecosystems in the manufacturing industry: Prerequisites, challenges, and benefits. *CIRP Journal of Manufacturing Science and Technology*, 37, pp. 414-426, 2022