ECONOMICS AND CULTURE 21(2), 2024

DOI: 10.2478/jec-2024-0023

THE ROLE OF INDUSTRY 4.0 IN THE CONTEXT OF ECONOMIC PERFORMANCE OF ENTERPRISES: A LITERATURE REVIEW

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Received 3 April 2024; accepted 31 October 2024

Abstract

Research purpose. This literature review aims to comprehensively examine the role of Industry 4.0 in shaping the economic performance and sustainability of enterprises within Central European countries and provide a nuanced understanding of the impact of Industry 4.0 technologies on corporate performance in this regional context. Implementation of Industry 4.0 technologies, such as IoT devices, artificial intelligence, and robotics, enhances operational efficiency. This efficiency can lead to cost reductions, improved production processes, and streamlined supply chains, positively impacting the economic performance of enterprises. Increased innovation often translates to the development of new products and services, driving revenue growth and positively affecting economic metrics.

Design / Methodology / Approach. Employing a literature review methodology, snowballing techniques, and bibliometric analysis, this study examines a wide range of scholarly articles, reports, and publications to discern patterns, current trends, and empirical evidence related to the nexus between Industry 4.0 adoption and corporate outcomes.

Findings. The findings reveal the multifaceted influence of technologies such as automation, artificial intelligence, and the Internet of Things on key economic indicators, including revenue growth, cost efficiency, and profitability, across various industries. Additionally, the review highlights the current trends, identifies methodological approaches, and suggests potential avenues for future research.

Originality / Value / Practical implications. This synthesis contributes valuable insights to the discourse on Industry 4.0's implications for economic performance and sustainability, adds significant value to the understanding of the intersection between technological advancements and economic outcomes in the business landscape, offering a foundation for scholars, practitioners, and policymakers interested in navigating the transformative landscape of advanced technologies within the business context.

Keywords: industry 4.0; economic performance; economic sustainability.

JEL codes: G30, M14.

Introduction

Economic health analysis is an indispensable component throughout the entire life cycle of a business. The economic condition of the organisation serves as a significant indicator of its present state. Corporations are compelled to adjust to the prevailing market conditions as a result of dynamic market shifts and persistent competitive pressure. Business managers have the ability to influence the future trajectory of the organisation by making decisions based on an assessment of its economic health. For instance, they may determine the company's future trends and orientations in order to enhance its

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competitiveness and appeal to potential investors. An essential economic indicator is the competitiveness of economies and businesses, as stated by Gavurova et al. (2020). Each sane entrepreneur initiates a business venture with the objective of achieving success. The company, however, ultimately encounters a crisis point and is compelled to adjust in order to survive in the business environment, as defined by the life cycles. However, the processes that operate within the organisation are also of equal significance. The advent of digitization has prompted significant changes in the course and structure of business processes, qualitatively altered methods and approaches in management, influenced modifications in established business models, generated the emergence of novel professions, and necessitated expansions of education, skills, and abilities among the human workforces. Moreover, it has caused a shift in the economy and has the potential to accelerate various significant developments.

The integration of Industry 4.0 within organisations aims to revolutionise industrial production through the implementation of cutting-edge technologies and digitization. To enhance global competitiveness, globalisation necessitates production that possesses sufficient adaptability to satisfy market demands (Schwab, 2016). This objective can be realised through the implementation of Industry 4.0 technology in the value chains and manufacturing processes of the organisation. In order to ensure the successful execution of Industry 4.0, the integration process must revolutionise industrial facilities into intelligent factories that prioritise connectivity and interoperability. Industry 4.0 is a technological and socioeconomic phenomenon distinguished by the implementation of information systems for product decision-making, intelligent manufacturing of big data, and advanced real-time analytics (Zabojnik, 2015). Real-time production planning, which is a defining feature of intelligent manufacturing facilities and the foundation of big data analysis in Industry 4.0 and artificial intelligence, enables interoperability and interconnection among the Internet of Things made possible by technological advancements. The inception phase of smart factory development (Malkowska et al., 2021) involved the manufacture of a solitary product utilising assembly lines comprised of devices that possess clearly defined functionalities. As the expansion persisted, additional opportunities, such as the mass production of a variety of goods, were investigated. Presently, computer numerical control (CNC) technology advancements permit flexible manufacturing. In order to adapt to the demands of a dynamic market, manufacturers have the ability to modify both the variety and quantity of their products.

Cyber-physical production systems, which form the foundation of intelligent facilities, are distinguished primarily by their autonomy and decentralisation. These systems integrate physical systems with information and communication technologies (Ionescu, 2021). Cyber-physical manufacturing systems communicate and capture data throughout the entire industrial process by integrating with real-time manufacturing planning via the Internet of Things. The communication protocol utilised by computer-physical systems is governed by informational Internet of Things systems that are AI-powered. Enhanced connectivity facilitates the acquisition and interchange of up-to-date information pertaining to every facet of industrial operations (Marik, 2016). Cyber-physical manufacturing systems are self-regulating, capable of analysing the outcomes of previous actions and learning from them while making decisions based on real-time data and algorithms. Software providers in decentralised smart factories include enterprise resource planning (ERP) applications, cyber-physical manufacturing networks, decision algorithms based on artificial intelligence, and manufacturing execution systems (MES) (Svabova et al., 2021). Maintaining consistent Wi-Fi connectivity is essential for facilitating communication among computers situated on the shop floor. The Industrial Internet of Things is a globally interconnected network that facilitates continuous connectivity and enhanced machine interaction in accordance with specific standards. The Industrial Internet of Things falls within the broader domain of the Internet of Things (IoT). This sector is predicated on the utilisation of sensor networks, big data-driven decision-making, and real-time monitoring of computerised physical systems (Bonab, 2017).

Some intelligent manufacturing duties require human-machine interaction due to the impossibility of completely automating them. Nevertheless, although these duties were previously executed manually, they remain a substantial progression. Humans can communicate with and provide information to machines. With the addition of life cycle monitoring and location sensors to manual production, smart factories are capable of manufacturing intelligent goods, which significantly simplifies maintenance

(Lazaroiu & Harrison, 2021). Product Lifecycle Management is a business activity that oversees and controls the complete life cycle of products, starting from their conception and ending with their retirement (Sjodin et al., 2018). It operates within computerised physical manufacturing networks and is accountable for the management of the manufacturing process. Considering the company's product identification and its contribution to anticipated profit, it functions as a critical element of intelligent manufacturing facilities while simultaneously safeguarding employee health. Product life cycle administration is, nevertheless, a formidable task. These components consist of organisational frameworks, personnel, product data, and various approaches, among others (Stark, 2016). Cloud manufacturing and big data analysis are essential components of Industry 4.0. Smart factory machines possess the capability to acquire knowledge and engage in real-time interactions with their surroundings, in addition to their tangible manifestations, by virtue of a cloud-based virtual identity (Tao et al., 2019). The implementation of cloud-based data collection in conjunction with cyber-physical systems enables the maintenance of uninterrupted data exchange (Pavlinek & Zenka, 2016).

Industrial artificial intelligence, IoT sensor networks, and real-time big data analytics are collaborating to facilitate the convergence of the physical and digital realms. Threat detection and decision-making in real-time are made possible through the collection and analysis of data (Verhof et al., 2021). It is a production-enhancing procedure that decreases errors. The proliferation of geographically dispersed data centres on a global scale enables organisations of all sizes to enhance and optimise their productivity. It is costly to construct one's own data centres and computing clouds. Intelligent networked sensors enhanced real-time analytics, and information systems for product decision-making are all components of Industry 4.0 (Schot & Steinmueller, 2018). Physical objects are created using additive manufacturing, also referred to as 3D printing, which operates by depositing successive layers into a three-dimensional framework, using digital 3D models as inspiration (Brioschi et al., 2021). The adaptability of additive manufacturing processes is what gives them their value. Before the advent of mass production, this approach was predominantly employed to rapidly prototype products (Horn & Ola, 2012), as it offered a cost-effective substitute for manufacturing small quantities of high-quality goods.

Furthermore, the integration of computational data into the physical environment is classified as an advanced manufacturing technology (Volker, 2014). This information may be transmitted to visual components that are incorporated into the enterprise's environment. Augmented reality assists employees with challenging duties in a dynamic workplace in real-time (Krulicky & Horak, 2021). Artificial intelligence (Goel & Gupta, 2020) is an innovative technological advancement that presents a positive supplement to the manufacturing process by empowering machines or computers to execute tasks that resemble human actions. Pisar & Bilkova (2019) define artificial intelligence as the capacity of machines to emulate human intelligence by utilising synthetic knowledge. Understanding intelligent learning-enabled processes requires an appreciation of the significance of IoT-based robotic systems in automated manufacturing operations. The variability in production utilisation of robots can be attributed to their suitability for distinct industrial sectors. Industry 4.0, which encompasses manufacturing, logistics, and office administration, is concurrently influencing the development of robot capabilities (Kubickova et al., 2021). Robot palletizing significantly affects both production time and output through the implementation of intelligently connected sensors, cognitive decision-making algorithms, and real-time process monitoring (Lamon et al., 2020). The imperative for enterprises to adopt Industry 4.0 is due to the pivotal function that technology plays in surmounting economic competition (Popescu et al., 2022). Not limited to production change, the implementation of Industry 4.0 encompasses all services and activities along the entire value chain (Vinerean et al., 2022). Organisations will probably seek to utilise Industry 4.0 technologies in conjunction with their current resources. It is necessary to devise a method for precisely transforming widely available technologies and devices to conform to this new paradigm (Hamilton, 2022; Nica, 2021).

The primary objective of this paper is to examine the role of Industry 4.0 in shaping the economic performance and sustainability of enterprises within Central European countries and provide a nuanced understanding of the impact of Industry 4.0 technologies on corporate performance in this regional context. This research endeavours to examine the convergence of Industry 4.0 and enterprise economic performance, providing an original viewpoint on the far-reaching consequences that digitalization and advanced technologies can have on business activities and economic results.

The paper is structured in a subsequent manner. The first part of the paper is devoted to the description of the methods used. Focusing on the literature review approach, bibliometric analysis offers an assessment of the existing literature in a quantitative way. The results and discussion section provide the outputs of the Web of Science articles analysis, using Bradford´s Law and bibliometric analysis in the form of bibliometric map and clusters which are formed by categorizing outputs into specific fields. These clusters are further discussed in a broader context. The conclusions section summarizes the main ideas of the paper, as well as the implications for policymakers, business professionals, and academicians who may learn from this assessment of Industry 4.0 adoption in different corporate units and take appropriate measures.

Research Methodology

By conducting a literature review that addresses new trends and impacts of I4 on the operation and economic performance of enterprises, valuable insights into how Industry 4.0 influences the economic performance of enterprises can be provided. To conduct the literature review, the Web of Science database was used. The initial search, using the combined words "industry 4.0" and "economic performance," brought 549 scientific outputs worldwide. However, to be able to analyse the documents, their relevance and significance in the given field, we focused only on the papers written in English and of course those, which could be easily retrieved. The final set consists of 84 documents which are further analysed (Table 1).

Table 1. Analysed sources (Source: created by the authors)

Description	**Results**
MAIN INFORMATION ABOUT DATA	
Timespan	2016-2023
Sources (Journals, Books, etc.)	60
Documents	84
Annual Growth Rate %	52.57
Document Average Age	2.57
Average citations per doc	28.19
References	6,563
DOCUMENT CONTENTS	
Keywords Plus (ID)	400
Author's Keywords (DE)	227
AUTHORS	
Authors	189
Authors of single-authored docs	3
AUTHORS COLLABORATION	
Single-authored docs	3
Co-Authors per Doc	2.25
International co-authorships %	21.23
DOCUMENT TYPES	
Article	84

Following a comprehensive analysis, the VosViewer software was employed to generate a term co-occurrence map from the text data and aggregate the most significant research categories. The factor weight influences both the label and circle size of the item. A closer appearance on the map indicates a stronger association between the terms, corresponding to a larger distance. On a cartographic representation, objects of greater mass are given greater prominence than those of lesser mass. The two weight attributes that are commonly used are the links property and the aggregate link strength attribute. According to Vosviewer (2024), the links and total link strength attributes of an item indicate the quantity and overall strength of links it maintains with other items, as well as the strength of those links specific to that item. The terms are categorised into distinct clusters based on their colouration; terms that are affiliated with the same cluster exhibit more intimate relationships than those that are not. An object may only belong to a single cluster. VOS Viewer supports a wide range of property types for its items. By default, items in the network visualisation are represented by their label and a circle. The colour of an object is determined by the cluster to which it is assigned. Connector lines are utilised to represent links. The map was generated utilising the normalisation method and association strength determined from bibliographic information. The association strength approach is utilised to normalise the intensity of the relationships between objects when this option is selected (Vosviewer, 2024).

Results

The period of the analysis was chosen directly from the beginning of the I4 principles into the corporate practice. With only three scientific outputs published in the first year (2016), the topic seemed to be in its early stages. The state of affairs remained unaltered until 2019. However, as illustrated in Figure 1, the implementation of the fourth revolution in technology was expedited by COVID-19, and businesses increasingly turned to big data, cloud computing, artificial intelligence, and the speed of 5G networks (French et al., 2021). Significant progress and contributions to research have been consistently observed since 2020 when the quantity of publications doubled to six. The acceleration of digital transformation and the integration of Industry 4.0 technologies into corporate operations in response to market dynamics and to ensure economic stability was clearly demonstrated by the COVID-19 pandemic. A substantial surge in the quantity of publications (29 scientific papers) occurred in 2023, suggesting that the discipline has either garnered considerable attention or that specific findings have stimulated further investigation.

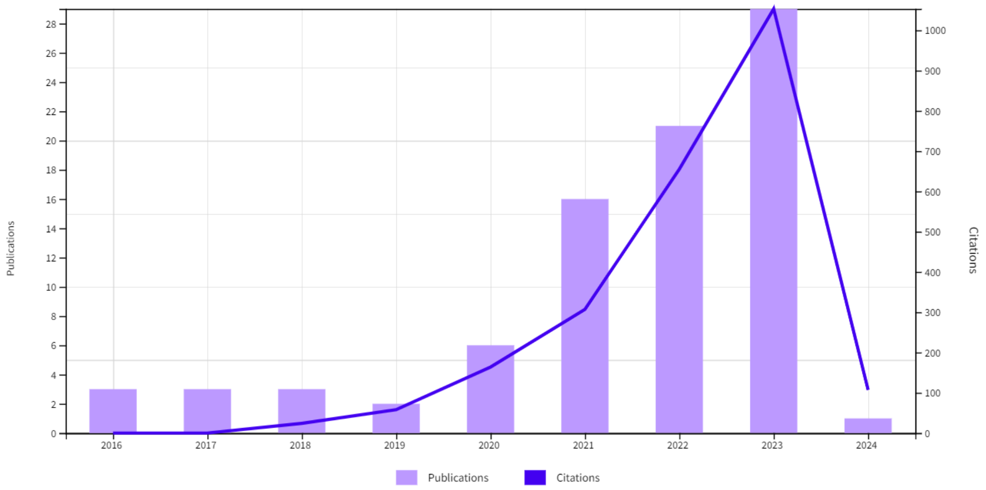

Fig. 1. Yearly research publication (Source: created by the authors)

Figure 1 also illustrates the number of citations received by the publications, indicating that the articles have had a significant impact. The number of citations has increased 10 times in the analysed period. In order to preserve conciseness and concentrate on the most abundant sources, table 2 only includes the top 10 most cited articles.

Table 2. Most-cited articles (Source: created by the authors)

Authors	Title	Cited by	Average citation per year
Kiel et al. (2018)	Sustainable industrial value creation: Benefits and challenges of Industry 4.0	365	45.63
Nagy et al. (2018)	The role and impact of Industry 4.O and the Internet of things on the business strategy of the value chain – The case of Hungary	276	39.43
Kohtamaki et al. (2020)	The relationship between digitalization and servitisation: The role of servitisation in capturing the financial potential of digitalization	258	51.6
Khan et al. (2021)	Industry 4.0 and circular economy practices: A new era business strategies for environmental sustainability	181	45.25
Dhamija & Bag (2020)	Role of artificial intelligence in operations environment: A review and bibliometric analysis	110	22.00
Tang et al. (2022)	Industry 4.0 technology and circular economy practices: business management strategies for environmental sustainability	106	35.33
Alkaraan et al. (2023)	Corporate transformation towards Industry 4.0 and financial performance: The influence of environmental, social, and governance (ESG)	85	21.25
Yu et al. (2022)	Circular economy practices and Industry 4.0 technologies: A strategic move of automobile industry	85	21.25
Potocan et al. (2021)	Society 5.0: Balancing of Industry 4.0, economic advancement, and social problems	69	13.8
Lin et al. (2023)	Industry 4.0: Driving factors and impacts on firm´s performance: An empirical study on China´s manufacturing industry	64	10.67

A summary of the article-based research areas that precisely correspond to the article's subject is provided in Figure 2. A significant proportion of papers (27%) are published in the field of business economics. With a combined total of 42 records, engineering and environmental sciences ecology are also the foremost research domains (according to the Web of Science database's categorization of journals into multiple research areas).

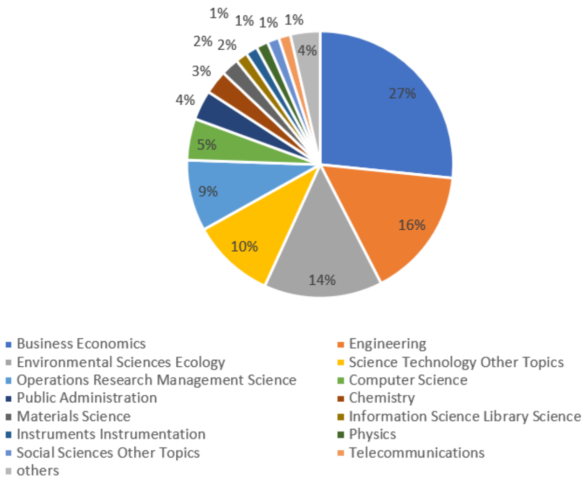

Fig. 2. Records distribution based on fields of the study (Source: created by the authors)

Based on the set of publications, Bradford´s Law was applied. This technique identifies three zones of productivity; thus, relevant journals can be split into three categories. Each group contributes to the same number of articles. As shown in Tables 2 and 3, zone 1 includes seven journals with a total number of 27 articles. The Sustainability journal is the one with the top position as it has published ten articles. This zone 1 features scientific journals that are probably the main resource for scholars working in the field and that regularly publish articles on the subject. Zone 2 includes 20 journals with a total number of 28 articles. This category includes a wider variety of publications (usually these journals published one or two papers) that are not exclusively focused on the topic but occasionally analyse it. Zone 3 has the widest variety of publications (29) which are published in 33 journals. Although these magazines do not routinely cover the research subject, only occasionally.

Table 3. Most frequent sources/journals (zone 1) (Source: created by the authors)

Journal title	Record count	% of 84
Sustainability	10	11.905 %
Technological Forecasting and Social Change	5	5.952 %
International Journal of Production Research	3	3.571 %
Business Strategy and the Environment	3	3.571 %
Applied Sciences Basel	2	2.381 %
Benchmarking An International Journal	2	2.381 %
Environmental Science and Pollution Research	2	2.381 %

Table 4. Zone-wise distribution of journals (Source: created by the authors)

Zone	Journals	% Journals	Articles	% Articles	Multiplier
1	7	11.67 %	27	31.14 %	-
2	20	33.33 %	28	33.33 %	2.85
3	33	55.00 %	29	34.53 %	1.65
Total	60	100	84	100	3.25

The accuracy computation is as follows:

$$\begin{gathered} 1 : n : n^2 \\ 7 : 20 : 33 \\ 7 :\ 7 \times 2.25 :\ 7 \times (2.25)^2 :: \ 1 : n : n^2 \\ 7 : 15.75 : 35.44 > 58.19 \\ \% \, error = \frac{58.19 - 60}{60} = -3.02\ \% \end{gathered} \tag{1}$$

The findings of the analysis indicate that Bradford's law accurately described the provided data, with an error rate of 3.02%. That is to say, it conforms to the law of dispersion within the designated mapping region.

The subsequent stage of the analysis involves the development of bibliometric maps that aggregate the most significant research categories and the generation of a term co-occurrence map. This map is generated using the text data. Bibliometric analysis quantitatively evaluates publications in order to detect patterns and trends. This process has resulted in the development of numerous significant topics that have significantly influenced the trajectory of the state of the art in this research field. We conducted a critical preparatory phase prior to clustering, during which we meticulously identified and eliminated synonyms to ensure the uniqueness of each category. Improving the accuracy and relevance of the resultant clusters necessitated the prevention of confusion between concepts that are conceptually similar but distinct.

The minimum number of occurrences of a term in our cases was established at level 10, with 28 terms satisfying the criterion. On the basis of the relevance scores calculated for each of these 28 terms, the terms deemed most pertinent were chosen. By default, sixty per cent of the most pertinent terms are selected. The parameters in question were implemented using Vos Viewer, an application that efficiently classifies the data (Figure 3). The factor weight influences both the label and circle size of the item. A closer appearance on the map indicates a stronger association between the terms, corresponding to a larger distance.

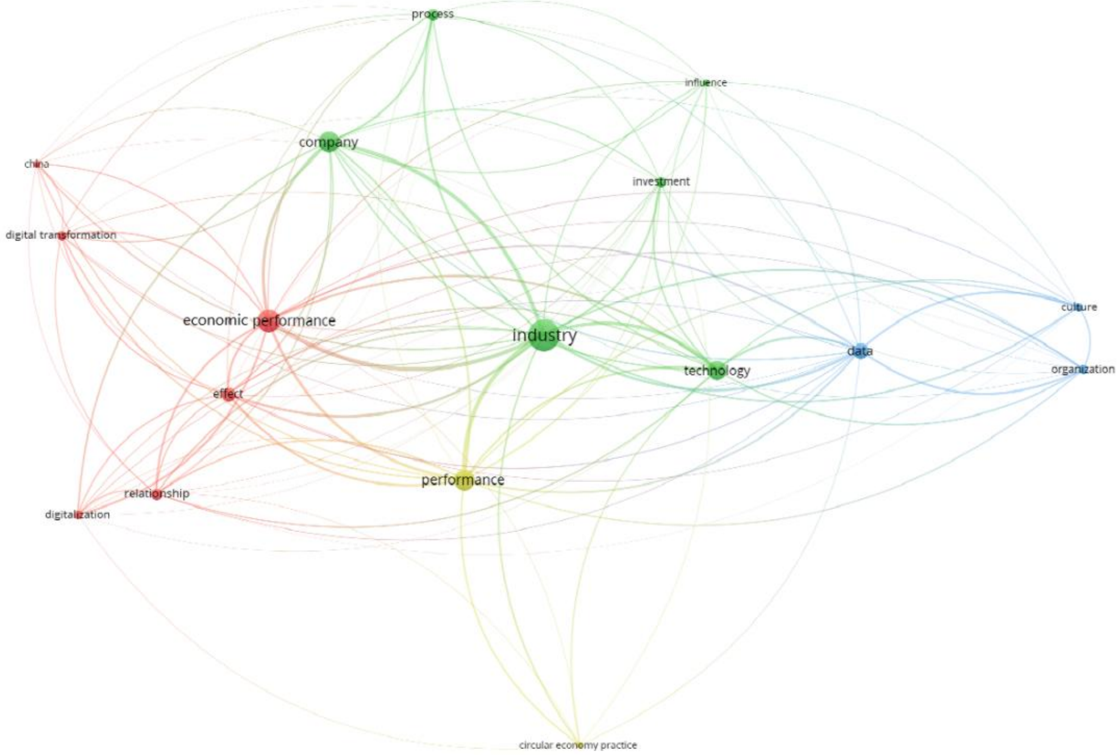

Fig. 3. Bibliometric analysis (Source: created by the authors)

Four significant clusters, each delineated by a distinct colour, are evident on the bibliometric map using the link data, total link strength, occurrence between keywords and their relevance. This visual representation provides insight into the progression and thematic structure of the influence of Industry 4.0 on the economic performance of businesses (see Table 5).

These clusters, which are derived from an analysis of scientific publications, also reveal current Industry 4.0 trends and their influence on the economic performance of businesses. With the aim of attaining operational excellence, businesses (particularly those in central Europe) are progressively adopting Industry 4.0 technologies within the framework of digital integration. The implementation of digital integration enables the supervision and regulation of manufacturing processes in real time, resulting in enhanced output and reduced expenses. In an effort to inform strategic decisions, organisations are placing a greater emphasis on data analytics, which capitalises on the enormous quantities of data produced by interconnected devices. The adoption of advanced technologies influences financial reporting practices, requiring adaptations to account for new business models and valuation methods. However, cultural, and institutional factors vary across the countries and the implementation and effectiveness of Industry 4.0 is strictly influenced by these factors, especially in terms of economic performance. Moreover, with the increasing reliance on data-driven decision-making, there is a trend towards investigating the ethical considerations associated with data usage in Industry 4.0 and also its role in promoting sustainability and green practices.

Table 5. Thematic evolution (Source: created by the authors)

Cluster	Terms included	Occurrences	Links	Total links strength	Relevance
Digital integration	digitalization	16	11	274	2.26
	digital transformation	20	11	289	1.16
	China	10	11	180	0.72
	economic performance	95	16	1,364	0.56
	relationship	26	16	389	0.48
	effect	38	15	639	0.43
Business operation	company	80	15	1,037	1.09
	industry	183	16	2,084	1.01
	process	25	13	336	0.70
	technology	64	16	913	0.49
	investment	18	14	273	0.36
	influence	10	13	177	0.30
Cultural factors	culture	14	19	327	2.30
	organization	16	11	365	2.23
	data	46	16	778	1.30
Circular economy	circular economy practice	11	8	165	1.05
	performance	79	16	1,188	0.57

Digital technology has a moderately positive effect on the overall performance of a corporation. However, innovation performance is most significantly impacted, followed by operational efficiency and economic performance (Oduro et al., 2023). Pucci et al. (2023) conducted an analysis of the significance of digital integration as it pertains to the economic performance of small and medium-sized enterprises. According to their findings, the extent of digital integration has a positive impact on firm performance, while digital integration itself has no effect. Moreover, organisations that prioritise open innovation may attain significantly superior performance results. Ribeiro-Navarette et al. (2023) demonstrated that the degree of digitalization, as assessed by the intensity of digital management, can account for differences between industries and businesses. Furthermore, the authors asserted that the greatest degree of digitalization is present in the largest organisations. Furthermore, small enterprises operating in less competitive countries make substantial investments in the environment, prioritising value creation over adherence to regulatory obligations (Herieda et al., 2023). Nevertheless, during periods of intense competition, major and extremely major corporations make substantial environmental commitments with the aim of enhancing their reputation and public acceptance. Finally, the researchers made the finding that the correlation between corporate environmental responsibility and the implementation of digitalization is impacted by the level of informality. Kohtamaki et al. (2020) proposed a nonlinear U-shaped interaction to describe the relationship between digitalization and service innovation that enhances economic performance. The results emphasise the criticality of a successful interaction between innovation and digitalization, as organisations may face the digitalization paradox if this interaction is not established. Thus, for organisations to generate value through service innovations, Industry 4.0 technologies must be implemented methodically (Atif et al., 2021). The correlation between I4 technologies and governance mechanisms is considered the most significant determinant of both the creation of sustainable value and the economic performance of an organisation (Alkaraan et al., 2023; Aldrighetti et al., 2023). Therefore, it is apparent that Industry 4.0 plays a crucial role in the process of value creation, as it produces the most substantial transformative impact (Nagy et al., 2018). Faria et al. (2022) conducted an analysis of the manner in which Portuguese enterprises enhanced their competitiveness, economic performance, and operational efficiency within the framework of the Industry 4.0 strategy subsequent to receiving governmental economic assistance.

According to Chaudhuri et al. (2024), Industry 4.0 applications accelerate the development of a culture of data-driven decision-making within an organisation. By bolstering their innovative capabilities and data-driven culture, the implementation of Industry 4.0 technology affects the social, competitive, and economic performance of businesses, according to a theoretical model developed using PLS-SEM. Michna and Kmeciak (2020) demonstrated that the inclination to implement Industry 4.0 in business entities is more significantly influenced by open-mindedness rather than knowledge-sharing. Furthermore, regardless of enterprise size, financial success, and the desire to adopt Industry 4.0 are positively correlated. Furthermore, it is critical to assess the impact of Industry 4.0 on supply chain capabilities and circular economy practices to optimise business performance (Dura et al., 2022; Yu et al., 2021). The empirical evidence substantiates the notion that Industry 4.0 has a positive influence on supply chain capabilities and the implementation of circular economy principles. In addition, empirical evidence establishes a correlation between circular economy methodologies and enhanced economic and operational performance of businesses. Liu et al. (2023) emphasised the significance of implementing I4 production technologies and fostering a circular economy culture in order to enhance the economic and environmental performance of businesses. The study by Khan et al. (2021) confirms that the emergence of new business models is supported by Industry 4.0 technology and circular economy practices. Moreover, in addition to its operational capabilities, Industry 4.0 possesses the capacity to substantially augment economic performance and environmental performance. As a result, the current research offers recommendations for organisations seeking to incorporate Industry 4.0 principles into their manufacturing operations with the aim of achieving sustainable goals (Alkaraan et al., 2022; Tang et al., 2022). Industry 4.0 integration has emerged as an innovative framework for industrial companies to address environmental and economic concerns, ensure competitiveness, and establish a viable business model in line with the prevailing circular economy trend (Ali et al., 2022; Samadhiya et al., 2023).

Industry 4.0 plays a pivotal role in enhancing the financial and economic performance of enterprises. The integration of advanced technologies, including automation, artificial intelligence, and the Internet of Things, significantly improves operational efficiency, leading to cost reductions and increased profitability (Kamble et al., 2020). By optimizing production processes and enabling real-time data analysis, Industry 4.0 allows firms to make informed decisions, which enhances financial forecasting and risk management capabilities (Schumacher et al., 2016). The scalability and flexibility offered by these technologies enable enterprises to quickly adapt to market changes, fostering a sustainable competitive advantage (Liao et al., 2017). Digitalization of supply chains, another key aspect of Industry 4.0, reduces lead times and inventory costs, which positively impacts the financial performance of firms (Zhou et al., 2015).

Additionally, the use of big data and analytics helps in identifying new revenue streams and customer preferences, leading to increased revenues (Russmann et al., 2015). The precision and customization enabled by Industry 4.0 technologies enhance product quality, allowing companies to capture higher market shares and improve profit margins (Moeuf et al., 2018). Predictive maintenance, powered by AI and IoT, minimizes downtime and reduces operational expenses, further boosting profitability (Qi & Tao, 2018). Despite the substantial initial investment required for adopting Industry 4.0 technologies, which may negatively affect short-term financial performance, these investments lead to long-term economic benefits (Oesterreich & Teuteberg, 2016). Overall, enterprises that implement Industry 4.0 are likely to experience improved financial resilience and superior economic outcomes in a competitive landscape (Kagermann et al., 2013).

Conclusions

A number of significant patterns have emerged within the domain of Industry 4.0 and its implications for corporate economic performance. The industrial sector's integration of advanced technologies and the adoption of digitalization have a substantial impact on the economic outcomes and operational processes of businesses. Initially, industry 4.0 incorporates a variety of technologies, including the Internet of Things, artificial intelligence, big data, and automation, which facilitate cost reduction and improved operational efficiency. Industry 4.0 facilitates a transition to more personalized and customized products and services. Enterprises are utilizing sophisticated technologies to satisfy the increasing demand for customized solutions, which in turn enhances customer satisfaction and loyalty and stimulates revenue growth. Consequently, this has a positive effect on economic performance. Industry 4.0 supports sustainability initiatives and CSR efforts by enabling resource optimization, energy efficiency, and waste reduction. Enterprises that embrace sustainable practices through Industry 4.0 technologies can enhance their brand reputation, attract environmentally conscious customers, and achieve long-term economic sustainability. Supportive policies, incentives, and regulatory frameworks are designed to foster innovation, investment, and competitiveness.

Moreover, the adoption of advanced technologies influences economic reporting practices, requiring adaptations to account for new business models and valuation methods. Many existing studies focus on short-term outcomes. Nevertheless, research should investigate the long-term economic implications of Industry 4.0 adoption, taking into account factors such as sustained competitiveness, market share, and overall economic sustainability over an extended period. There is a lack of comprehensive studies exploring how the adoption of Industry 4.0 technologies correlates with the economic performance of enterprises of different sizes in Central European countries. Understanding the impact on small and medium-sized enterprises (SMEs) versus large corporations is crucial. However, analysing the role of Industry 4.0 in shaping the economic performance and sustainability of enterprises, the current study was solely focused on the articles from the Web of Science database, which were available for free download and only in the English language, which may be considered the main limitation of the study. Thus, further research should be focused on this issue to reveal the development and implementation of Industry 4.0 in European enterprises and reveal if the trends in this field are the same compared to the global ones. Offering a foundation for academics, practitioners, and policymakers interested in facing the transformative landscape of advanced technologies within the business context, this analysis adds significant value to the understanding of the intersection between technological advancements and economic outcomes in the environment of business entities. It also adds valuable insights to the discourse on Industry 4.0's implications for economic performance and sustainability.

Acknowledgements

This research was financially supported by the Slovak Research and Development Agency Grant VEGA 1/0494/24: Metamorphoses and causalities of indebtedness, liquidity, and solvency of companies in the context of the global environment and institutional grant of the University of Zilina 4/FPEDAS/2024.

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