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Research Article

Implementing Digital Solutions to Safeguard the Economic and Legal Stability of Industrial Enterprises

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ABSTRACT

Introduction: In today's technological world, digital transformation has become a prerequisite for the successful operation of any enterprise. This digital transformation is fundamentally changing approaches to doing business, setting new standards of efficiency and competitiveness in the global market.

Objectives: The study aims to qualitatively assess the current level of use of digital tools for integrated management of industrial enterprises' economic and legal security, identify potential areas for developing digital security in this area, and justify the need to introduce cyber defence in the current business environment.

Methods: The study was conducted using a set of methods, including theoretical analysis, empirical research, and regulatory and legal analysis of the problem of using digital tools to ensure industrial enterprises' economic and legal security.

Results: The article presents a study that covers both the impact of digital transformation on business and the analysis of current trends and challenges in this area. It has been proved that digital transformation involves introducing innovative technologies that automate processes, optimise resource management, and facilitate the adoption of sound management decisions. The international indices that assess countries' digital development level, particularly the quality of communication, availability of digital services and cybersecurity, are analysed.

Conclusions: Thus, the current business challenges associated with digital transformation are identified. The author identifies typical obstacles in managing industrial enterprises with the introduction of digital transformation, areas of implementation and several digital tools to ensure their digital security, and provides proposals for the introduction of legal mechanisms for digital transformation.

Keywords: digital transformation, information and communication technologies, big data tools, cybersecurity, industrial enterprises.

INTRODUCTION

The rapid development of science and technology is a powerful driver of economic transformation at the enterprise level. Digital transformation opens up new opportunities for industrial enterprises to grow and develop, but this process requires significant investments, changes in organisational culture and staff development. Companies that successfully implement digital transformation gain competitive advantages and ensure sustainable development.

The transition to Industry 4.0 is accompanied by the emergence of new types of risks associated with digital technologies and specific features of particular business sectors. This has led to a significant complication in the overall risk situation, particularly in industrial enterprises [1]. Industry 4.0 is a new stage of industrial development characterised by fully automated production controlled by intelligent systems that constantly interact with each other and the external environment, creating a global network of industrial facilities and services.

Many businesses are currently undergoing significant transformations of their production processes aimed at increasing efficiency, reducing costs and adapting to changing market conditions by implementing modern digital solutions as part of the digitalisation of production processes, such as modular production, the creation of collaborative platforms, product customisation and increased environmental friendliness, including the introduction of energy efficiency systems. However, alongside these positive trends, the digital transformation of production is accompanied by several challenges that negatively impact the ability of businesses to protect their economic interests and comply with legal regulations. The increasing number and complexity of cyberattacks, the dependence of production processes on digital technologies, and the challenges of protecting intellectual property and data privacy make the digitalisation of production a process that requires a comprehensive and multilateral approach to security

The rapid pace of digitalisation in all business areas requires lawmakers to constantly monitor market changes and promptly amend legislation to support creating a favourable environment for enterprise development and digitalisation. That is why ensuring security in the digital economy and legal space is one of the most pressing challenges of our time.

LITERATURE REVIEW

The problem of the impact of digital transformation on the activities of enterprises is the subject of numerous scientific studies, which indicates its high relevance and versatility. Over the past decades, scholars such as [2], [3] have been actively studying the impact of digital transformation on the economy, politics and culture of society, focusing on aspects such as the development of artificial intelligence, the Internet of Things and big data. [4] argue that digital transformation is not a superficial process but a fundamental change in business models, consumer habits and social relationships. Various aspects of the digital transformation of society are the subject of scientific research; for example, [5] argue for the need for cooperation between blockchain, artificial intelligence and the industrial Internet of things in the digitalisation of enterprises, given that each of these technologies has its unique capabilities. However, it is in their interaction that the real potential for creating innovative solutions lies.

Digital transformation will undoubtedly become a determining factor for business, creating new opportunities and challenges for enterprises. [6] assure that there are two main areas in which digitalisation is taking place, namely productivity and the creation of fully digital enterprises in the future. Even considering the main trends in the development of the digital economy in the EU, there is an increasing reliance on data analytics and artificial intelligence to drive economic growth and innovation [7]. It is the stimulation of digital transformation that allows businesses to optimise production, reduce costs and increase profits, as noted by [8]. In particular, digital technologies allow to quickly adapt production to changing market conditions and customer needs, optimise energy consumption, which leads to lower energy costs and delivery routes, and create personalised offers, which increases customer satisfaction and sales; blockchain provides a high level of transparency and trust in data, which is essential for building long-term relationships with partners and customers. [9] argue that augmented intelligence through the introduction of voice assistants, image recognition, autonomous vehicles, robotics, and predictive analytics capabilities has empowered digital tools, transforming them from simple communication tools to powerful tools for data analysis, automation, and decision-making in industry. Blockchain, in turn, can ensure data integrity and transparency, providing a reliable basis for business intelligence applications, and its integration with artificial intelligence elements, according to a study by [10], and [11] creates innovative solutions in various areas of production activities, such as supply chain management, finance and the production structure of the enterprise.

It is clear that all these modern processes have both a positive impact on the development of enterprises and leave some security issues, including the presence of such phenomena as hacker attacks, phishing, viruses and malware, the possibility of disinformation and manipulation of private data, dependence on digital technologies and possible social isolation, as emphasised by [12]. That is why modern scholars are actively researching the theoretical foundations and practical aspects of building a sustainable economic security system in digital transformation [13]. Baddam [13], for example, argue that consumer behaviour, cybersecurity, regulatory frameworks and technological

advances that affect the digital financial ecosystem of an enterprise are also revealed through secondary data. Digitalisation fosters financial inclusion, economic empowerment and innovation but also creates regulatory uncertainty, cybersecurity risks and technological limitations [15]. Policy implications for digital financial safety include regulatory clarity, risk-based regulation, cybersecurity resilience, and consumer empowerment. To increase economic security and trust in the digital economic ecosystem, as noted by Shostak [16], regulatory clarity, risk-based regulation, cybersecurity resilience, and consumer education, among others, should be prioritised.

The interdisciplinary nature of the digital economy requires close cooperation between economists and lawyers to develop effective regulatory models. According to [17], to regulate the development of the digital sector of society, it is necessary to form and operate institutional, legal, economic, organisational, socio-psychological, technical and technological mechanisms with a wide range of methodological tools for each of them. But despite the rapid development of the digital world, scientific thought has not yet formulated a complete picture of these changes and methodological tools [18]. Economists and practitioners' growing attention to the digital economy creates the need for a new legal framework that adequately regulates relations in the digital environment [19], [20]. To overcome these difficulties, it is necessary to combine the efforts of lawyers, programmers, economists and other specialists to develop new legal instruments. Despite significant advances in digital transformation, the impact of digital technologies on the security of economic and service businesses requires further study.

The work aims to study the current state and prospects for using digital technologies to manage industrial enterprises' integrated security systems in the economic and legal spheres. The author's task is to substantiate the prospects for further development of the effective use of digital transformation tools related to cybersecurity in the current economic environment.

METHODS

The study used general scientific methods, including generalisation, synthesis, scientific abstraction, analytical diagnostics, and regulatory and statistical analysis. A comprehensive approach, including the dialectical method, formal logic, and system analysis, was applied to the in-depth analysis of the socio-economic processes of the digital transformation of industry. The application of regulatory and legal analysis methods has made it possible to identify the main elements of the legal environment necessary for the effective use of digital technologies in industrial management.

ICT is the driving force behind international comparative research, providing access to vast amounts of data. The analytical diagnostics method allowed us to study the key indicators that characterise the level of digitalisation of the European economy in general and the industrial sector in particular. The results were interpreted using open data from the Digital Decade DESI visualisation tool (composite index), Measuring digital development ICT Development Index [21] (an integral indicator that reflects the overall level of development of information and communication technologies), NCSI [22] (an integral indicator that gives a general idea of the state of cybersecurity) and Open Data in Europe [23] (including the % of open data in the business sector) for 2023.

Using the method of generalisation and synthesis, it was possible to combine all the scientific results obtained into a single vision that reflects the relevance of the problem of using digital tools to ensure industrial enterprises' economic and legal security. A systematic review of scientific publications by world scholars and other sources of information on the topic made it possible to determine the current state of scientific research in the field of digital transformation, identify problems of economic and legal security management, in particular, cyber threats, in the field of industry and formulate our conclusions.

RESULTS

Today's economy is developing rapidly, with digital technologies driving progress in any business. Digital transformation is an integral part of modern industrial development. Using digital tools makes it possible to increase production efficiency, create innovative products and services, and adapt to changing market conditions, and companies that successfully implement digital transformation gain competitive advantages and ensure sustainable development.

The exponential growth in the data generated by businesses is challenging traditional information processing methods and requiring the development of new innovative solutions. Due to the growing amount of data and the development of analytical tools, companies can conduct in-depth market analysis, identify new opportunities and

optimise business processes, which allows them to make more accurate and timely decisions and increase their competitiveness [3]. Indices such as the ICT Development Index, DESI, the e-Government Development Index, the Global Cybersecurity Index, and the Open Data Maturity rating are used for a comprehensive analysis of the economy's digital maturity level. Information and communication technologies are indispensable for comparative studies covering different geographical levels. This allows us to identify leaders and outsiders in the field of digital transformation, as well as to identify general development trends at the global geopolitical level and helps to identify weaknesses in the development of digital infrastructure, Internet access, and digital skills of the population.

As the ICT Development Index (Figure 1) shows, while the digital divide between European countries in terms of informatisation a still exists, it is likely to be narrowing thanks to European investment in digital technologies, including the development of broadband, mobile networks and other critical elements of digital infrastructure, and policies aimed at ensuring digital inclusion. A high digital development ranking can attract foreign investment, as it indicates a favourable environment for doing business and helps countries share experiences and cooperate in digital transformation [24].

A high DESI score indicates a favourable business environment that attracts investment from both internal and external sources. Companies from countries with a high DESI [25] (Figure 1) are more competitive in the global marketplace. They can use digital technologies more effectively to optimise their business processes, improve the quality of products and services, and enter new markets [7]. It is an essential indicator for the business sector, as it reflects the overall level of a country's digital development and affects critical factors such as investment attractiveness, innovation, competitiveness, and cooperation.

Regular cybersecurity assessment is a fundamental component of national security. This allows timely identification and elimination of vulnerabilities, increasing the security of information infrastructure and creating conditions for successful digital transformation, particularly in the field of industry [12]. In response to growing threats, European countries are increasing investments in the development of cyber defence systems and training, strengthening cybersecurity cooperation to share information on threats and develop joint defence strategies, and expanding and clarifying cybersecurity legislation, especially in terms of liability for cyber attacks and personal data protection, and as a result, maintaining leading positions in the Cybersecurity Index ranking (Figure 2).

The Open Data Maturity ranking is a powerful tool for assessing countries' digital maturity and potential for innovation [26], [27]. This ranking is significant for the industrial sector, as open data can catalyse significant change and growth, which is why developing open data is a priority for any country seeking sustainable economic development. As Figure 3 shows, as of August 2024, France has demonstrated the most mature approach to open data, providing broad access to government information and developing an ecosystem for using this data. The second place was taken by Poland, which is also actively working to expand access to open data and use it to develop society and the economy. Ukraine rounds out the top three, reflecting the country's significant efforts to open up data despite the difficult situation caused by martial law.

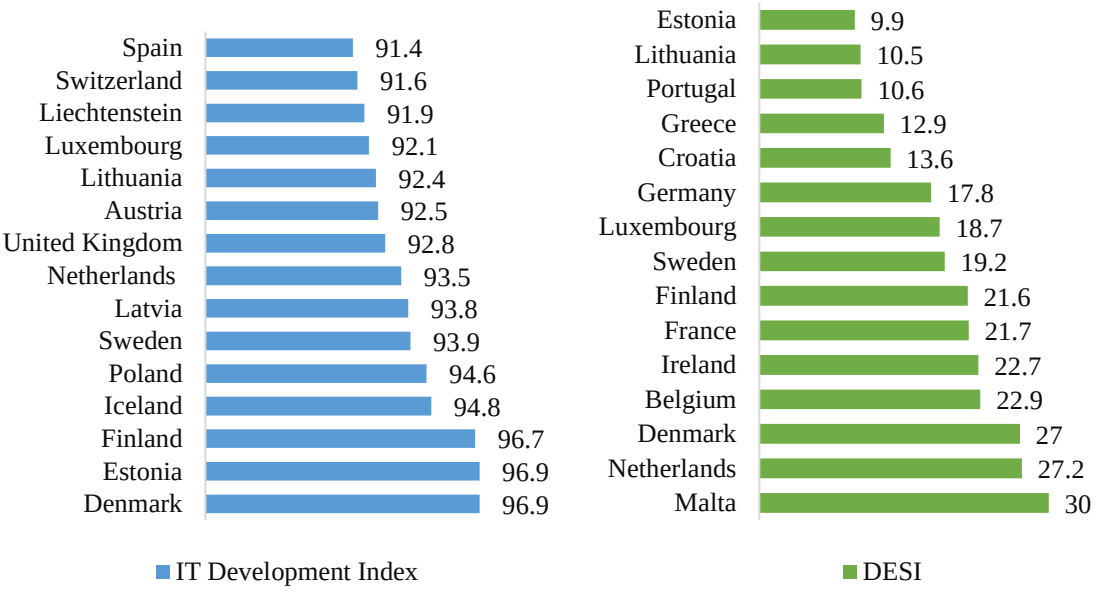

Figure 1. Leading European Countries according to the ITC Development Index [21] and DESI [25] in 2023

Source: based on data from Measuring digital development [21]; Digital Decade DESI [25] visualisation tool, n.d.

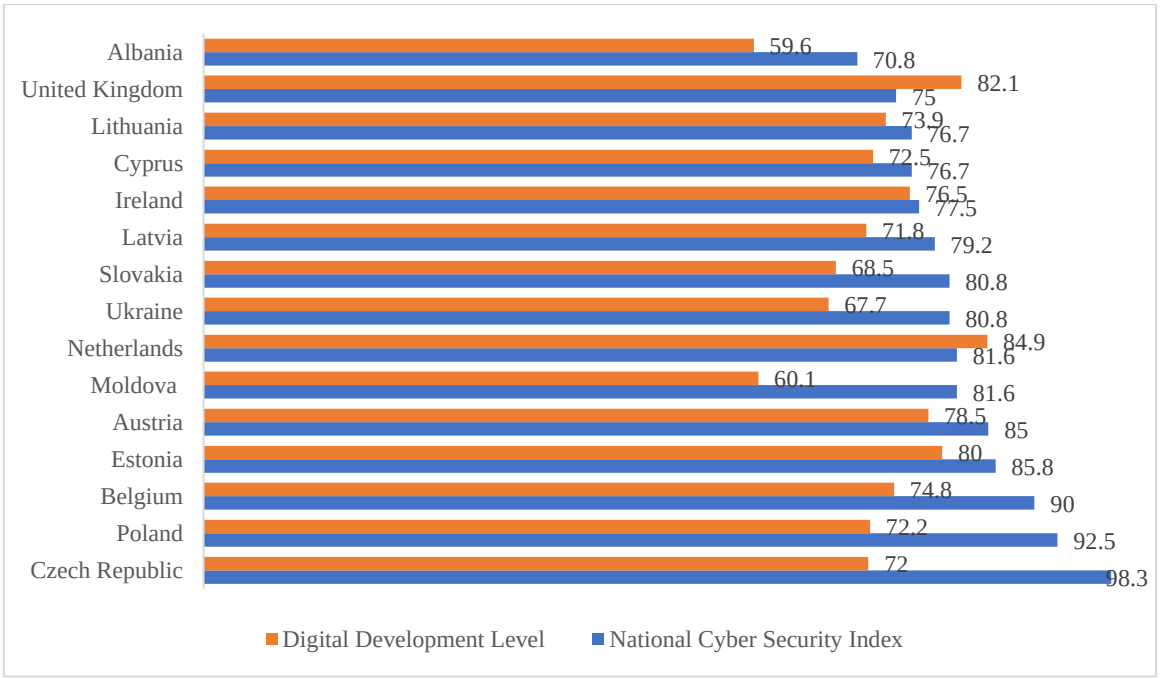

Figure 2. Leading European Countries by National Cyber Security Index compared to Digital Development Level, as of August 2024

Source: based on data from Digital Decade DESI [25] visualisation tool, n.d.

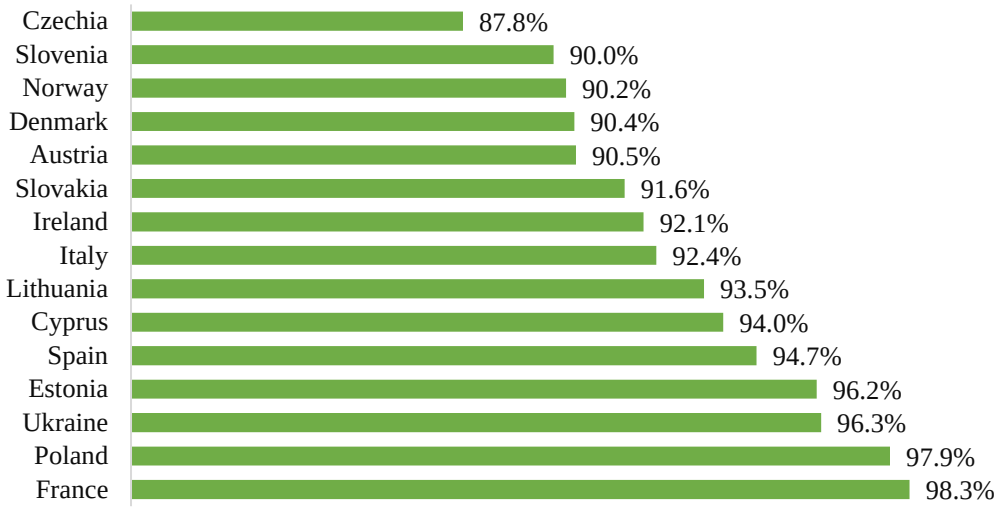

Figure 3. Overall Ranking of Europe's leading countries by Open Data Maturity indicator for 2023

Source: based on [23]

Europe's industrial sector is undergoing a period of significant transformation driven by both global trends and domestic factors, including the ongoing digitalisation of society, growing awareness of environmental issues, an ageing population and a shortage of skilled workers, changes in international trade, and, as a result, increased competition from other regions, especially Asia, require European industry to adapt to the new environment. Many European countries are facing the problem of optimization, especially in traditional industries such as metallurgy and textiles. However, a parallel restructuring process is taking place, focusing on high-tech production and innovation. The introduction of advanced technologies, including the Internet of Things, artificial intelligence and big data, radically changes production processes, increasing efficiency and flexibility.

At first glance, the claim that the industry level is growing in all European countries may seem contradictory against the backdrop of globalisation, optimization and digital transformation. Some traditional industries, such as steel and textiles, face significant challenges. Competition from Asia remains strong, and geopolitical instability could negatively affect European industries. However, overall, there are positive developments related to digital transformation, a focus on high-tech industries and government support (Figure 4).

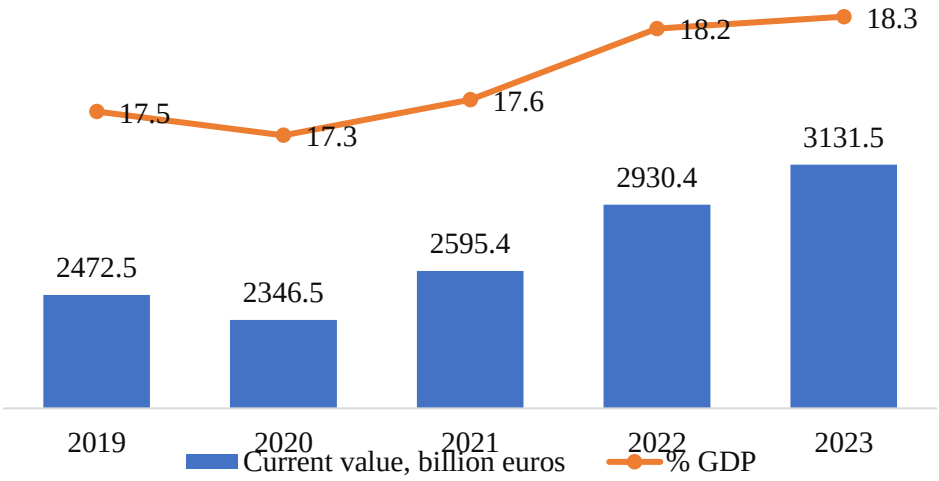

Figure 4. Development of the European Industrial Sector (excluding construction) in 2019–2023

Source: based on data from [28]

Digital transformation is radically changing the vectors of industrial development, opening up new opportunities for growth and development. The development of technologies such as automation, robotics, and artificial intelligence is increasing productivity and reducing production costs, stimulating the creation of new businesses [29]. Although digital transformation offers excellent opportunities for the development of industrial enterprises, its implementation often faces several obstacles, as detailed in Table 1. Rash implementation of digital innovations can upset the balance in the existing management system of an industrial enterprise and lead to unpredictable consequences.

Table 1. Typical Common Obstacles in the Management of Industrial Enterprises with the Implementation of Digital Transformation

Obstacles	Reasons	Resistance content
Updating corporate values	Adaptability to change	Resistance to change inherent in corporate culture can make it difficult to implement modern technological solutions
	Lack of a culture of innovation	Not all firms are open to new things and ready to change, so it is difficult for them to go digital
Human resources	Insufficient funding	Significant investments in infrastructure, staff training and new technologies create a significant financial barrier
	Shortage of appropriately qualified specialists	Lack of the right specialists can slow down enterprise digitisation
Security-related issues	Cyber threats	Increasing volumes of digital data and the growing number of cyberattacks pose significant cybersecurity threats
	Data security breaches	The possibility of data breaches discourages companies from bold digital experiments
Lack of unified requirements	Regulation	A variety of standards creates barriers to system integration
Unwillingness to change	Resistance of the staff	Without team support, any digital transformation is doomed to failure
Existing information systems	Legacy systems	Legacy systems can create barriers to the seamless integration of modern digital solutions
	Uncoordinated systems	Lack of integration between systems hinders data exchange and collaboration
Legal restrictions	Information security issues	Regulations in the area of personal data protection may hinder the development of digital technologies
Ineffective strategy	Suboptimal choice of technology stack	The choice of technologies should be justified and meet the specific needs of the organisation

Source: compiled by the author based on [3]

The systematic use of innovative IT technologies and algorithms is a key factor in the digital transformation of enterprises, as they create a single digital space characterised by high interaction and mobility. The technological basis of modern developments is based on the achievements of the Fourth Industrial Revolution, including artificial intelligence, robotics, extensive data analysis, digital platforms, and additive technologies (3D and 4D printing) [30].

Technological support for the digital transformation of industry consists of three interrelated technologies: technologies for working with data, technologies for optimising production processes, and technologies for interacting with the external environment. The critical digital technologies in industry today include artificial intelligence, machine learning, big data, cloud computing, blockchain, the Internet of Things (IoT), augmented reality (AR) and virtual reality (VR), and cybersecurity. For example, cognitive technologies are integral to Big Data technologies as a tool for processing large data sets (Figure 5).

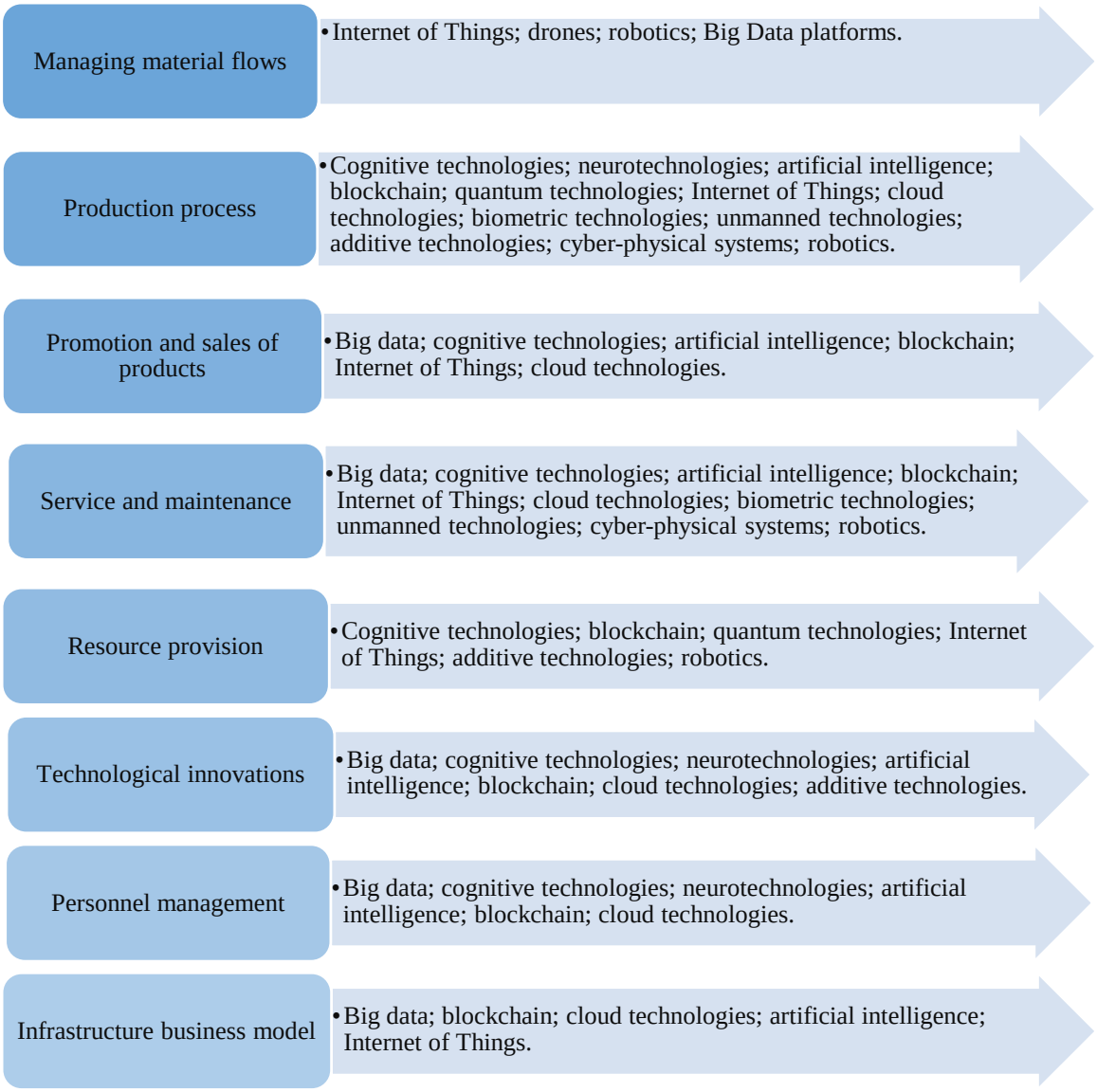

Figure 5. Implementation Areas and Digital Tools in the Operations of Industrial Enterprises

Source: based on [31]

The choice of the best digital tools depends, among other things, on the size of the enterprise, the specifics of production, and the available budget. A comprehensive approach, including various tools and ongoing staff training, is the key to adequate protection against cyber threats. Figure 6 shows various digital tools used to protect industrial enterprises from cyberattacks and other threats.

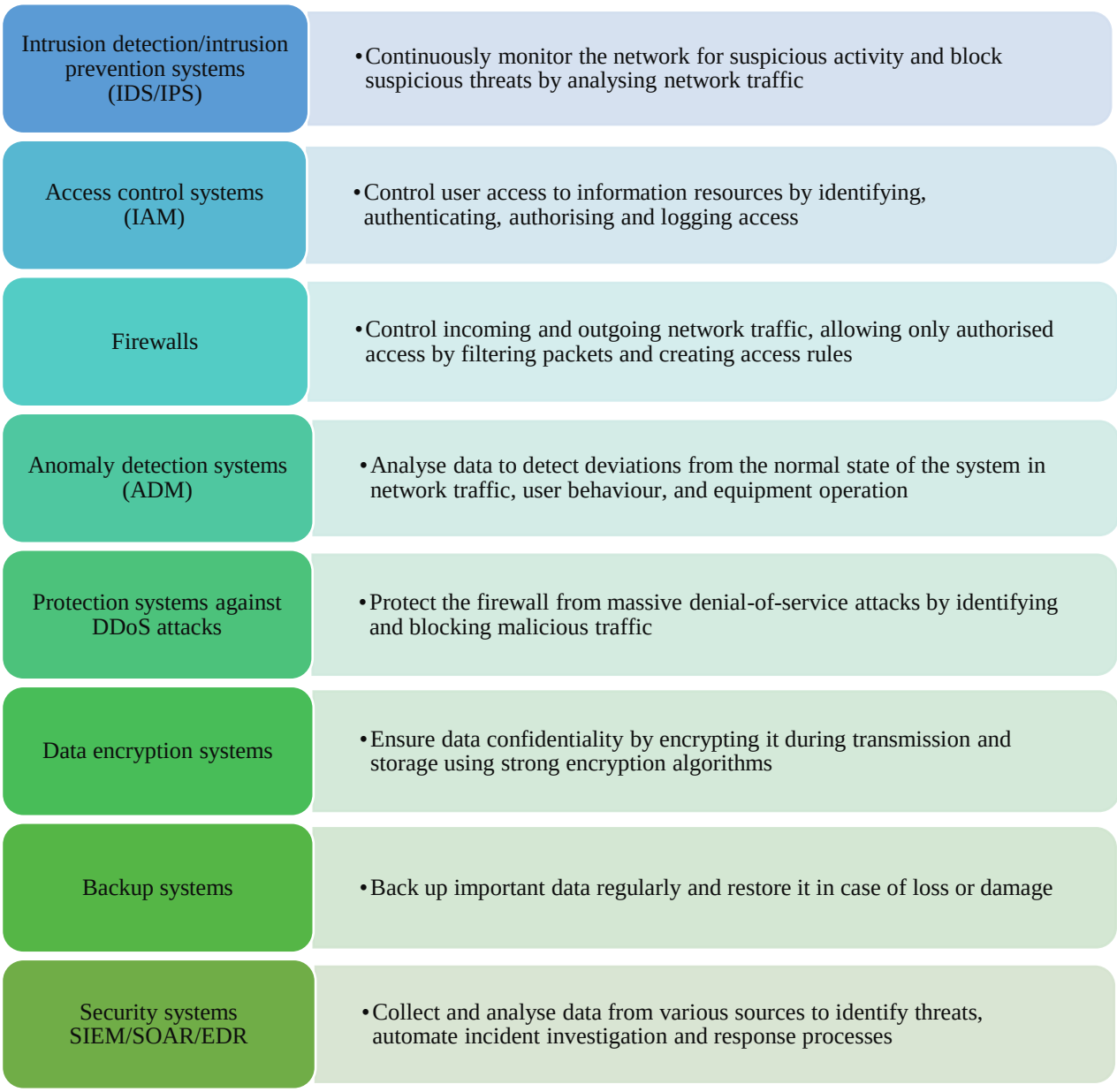

Figure 6. Digital Enterprise Security Tools

Source: compiled and supplemented by the author based on [5]

Automating processes with the help of these technologies avoids many of the errors typical of manual labour, ensuring high accuracy and reliability of tasks. In addition, these technologies facilitate close cooperation between all process participants, increase work efficiency and reduce labour costs. It is worth noting that the specifics of businesses in different industries determine different levels of readiness for digital transformation and different impacts of digital technologies. Companies engaged in producing goods have a longer production cycle and, as a result, a longer return on investment. At the same time, they use a much more comprehensive range of digital technologies to optimise and automate production processes than service companies [32].

The global digital transformation is accompanied by the emergence of new objects of legal relations, including digital assets, which requires the development of new legal mechanisms for adequate legal regulation of this area (Table 2). Digital technologies give rise to new legal relations that require a clear definition of the participants' rights, obligations and responsibilities. This is especially difficult when no direct human interaction exists in such relations.

That is why developing new legal mechanisms is a complex problem that requires the involvement of lawyers, technology experts, and business and civil society representatives.

With big data, we can identify new patterns and trends in data that were previously unavailable for analysis. Raw enterprise data scattered across different sources does not have much potential. However, thanks to intelligent analysis based on specified parameters, it turns into valuable data that can be used to make informed decisions. These technologies are used in various industries to automate processes, analyse data, predict trends and personalise user services.

Table 2. Proposals for Implementing Legal Mechanisms for Digital Transformation

Field of application	Direction	Essence
Security of personal information	New standards for data collection, storage and processing	As digital interaction increases, the amount of personal data collected grows exponentially. Stricter standards for the collection, storage and processing of this data need to be developed to protect the rights of individuals
	The right to be "forgotten"	Personal data subjects have the right to have their data deleted from the relevant databases.
	International cooperation	An international personal data protection regulation is needed to ensure the protection of citizens' data in the global digital space
Regulation of artificial intelligence	Responsibility for AI actions	Liability if a decision made by artificial intelligence leads to negative consequences
	Transparency of algorithms	Algorithms need to be transparent so that people understand how decisions are made based on data
	Ethical principles	Ethical principles should be set for the development and application of artificial intelligence technologies
Digital economy	Regulation of digital platforms	Large digital platforms have a significant impact on the market. Rules should be created to prevent abuse of their dominant position
	Digital competition	We need to ensure fair conditions for competition in the digital market
	Taxation of digital companies	Effective taxation mechanisms for digital companies need to be created so that they pay taxes in the countries where they make their profits.
Cybersecurity	Liability for cyber attacks	Responsibility for cyberattacks should be determined, and effective mechanisms for compensation should be developed
	International cooperation in the fight against cybercrime	International cooperation to fight cybercrime needs to be strengthened
Copyright in the digital world	Copyright protection	Improved methods of copyright enforcement in the context of widespread digital content should be invented
	Licensing	New licensing models need to be developed to meet the needs of the digital age
Smart contracts and blockchain	Legal recognition of smart contracts	It is necessary to determine the legal status of smart contracts and ensure their enforcement
	Blockchain regulation	A regulatory framework for blockchain technology needs to be formed
Artificial intelligence and autonomous vehicles	Responsibility for actions	Determining who is liable if an autonomous vehicle causes an accident
	Regulation of use	Rules should be developed for the safe use of autonomous vehicles

Source: compiled by the author

The General Data Protection Regulation (GDPR) is comprehensive European legislation aimed at ensuring and protecting individuals' rights regarding the processing of personal data. It aims to protect individuals' personal information by establishing clear rules for collecting, storing, and processing such data and providing conditions for their cross-border transfer. Cloud computing, artificial intelligence, and other digital technologies are vital areas requiring immediate legal regulation.

Therefore, in order to use digital data effectively, industrial enterprises need to constantly update and improve their technological capabilities. This will increase efficiency, competitiveness, and adaptability to changing market conditions. Despite the need to overcome specific difficulties, the transition to new technologies is a more rational solution, as it ensures increased efficiency and safety of production.

DISCUSSION

The digital economy, as a set of new digital sectors and traditional industries transformed by digital technologies, adds a new impetus to economic development and promotes social transformation. The concept of the fourth industrial revolution reflects the current stage of economic development, characterised by active interaction and rapid changes in production and digital technologies, accompanied by the intellectualisation of labour [33]. The digital revolution is changing the game's rules in social interaction, creating new opportunities for communication and collaboration. Thanks to digital transformation, businesses can ensure sustainable development, as data allows them to accurately predict market trends and adapt to changes [34].

Global digital transformation involves not only technological changes, such as the use of artificial intelligence, the Internet of Things, cloud computing, blockchain as a basis for cryptocurrencies, augmented and virtual reality, and the introduction of biometric technologies but also a radical restructuring of the entire enterprise management system, from the formation of strategic goals to their implementation in practice, including the development and implementation of new business ideas and the revision of strategic goals [2]. Successful digital transformation depends on the organisation's flexibility and ability to respond quickly to changes and effectively use modern digital tools to solve complex problems [35]. Despite its many benefits, it also poses new challenges for businesses, with the need to adapt to rapid changes in the technological environment, enhance cybersecurity, and manage large amounts of data.

Integrating digital technologies with the natural world allows for the creation of virtual environments that mimic real-world conditions, opening up new opportunities for modelling, testing, and improving products at the early stages of development, significantly reducing costs. Rapid knowledge accumulation, focus on innovation, and flexible forms of organisation allow industrial enterprises to respond flexibly to market challenges, minimise costs, improve the quality of management, and ensure a sufficient state of economic and legal security [36].

Modern industrial enterprises must be flexible to respond quickly to market trends and ensure sustainable business development. Innovative technologies increase productivity and ensure more efficient resource use, increasing the enterprise's economic efficiency. In manufacturing, leading companies actively use digital technologies to automate production processes and improve product quality [9].

The economic sustainability of an enterprise is formed as a result of interaction with other business entities and depends on its place in the overall system of economic relations. At this level, economic security objectives go beyond making a profit and include combating unfair competition, corruption and raiding. The way to economic security is through a scientifically based understanding of its essence and the challenges faced by specialists in this field [37]. The critical element of ensuring the economic security of a company is to preserve the integrity and protect its assets and interests, which implies the responsibility of each employee, including the security service, planning and economic department, accounting and IT specialists. Only with the rational use of all resources can an enterprise successfully implement its plans and guarantee comprehensive protection [10].

Given the increasing role of digital technologies in society, there is a need to develop new legal approaches and adapt existing rules to new realities. The concept of big data involves using special tools to analyse large amounts of data and identify hidden patterns. New technologies provide businesses with new development opportunities but, at the same time, pose a threat to data privacy and can be used for unfair competition. It is necessary to create a flexible legal system to provide favourable conditions for investing in digital technologies and stimulate innovation by all market participants [18].

CONCLUSION

The study found that complex transformation processes characterise the current state of European industry. On the one hand, European industry faces several challenges; on the other hand, new development opportunities are opening up. The government, business and civil society need to work together to overcome the challenges and realise

the potential. Measures to strengthen European industrial capabilities, such as creating joint research centres and supporting innovative projects, can help Europe maintain its leadership position in industry.

The results of the research carried out to substantiate the processes of digital transformation in the field of industry, to qualitatively assess the current level of application of digital tools for the integrated management of economic and legal security of industrial enterprises, identify potential areas for the development of digital security in this area and justifying the need to implement cyber defence in the current business environment, allow us to conclude that

Digital transformation creates new development opportunities and increases the risks associated with privacy breaches, fraud, and other IT-related crimes.

Industrial digitalisation is complex and multifaceted, requiring companies to adapt to new technologies and change their culture and working methods. However, this transformation creates the basis for innovation, growth, and achieving new goals.

Thanks to their ability to model the global digital space, innovative IT technologies provide the foundation for the digital transformation of industrial enterprises, facilitating increased interaction and mobility.

When assessing digitalisation's impact on industrial enterprises, it is necessary to focus on how it changes each stage of production and adds value to the product. Digital technologies will open up new opportunities for enterprises to optimise internal processes, ensure transparency of activities, and accelerate the launch of new products and services.

To succeed in digital transformation, it is necessary to address economic and legal security issues in parallel. A synergistic approach, which includes a set of technical, organisational and legal measures, helps to reduce the likelihood of risks and ensure the stable operation of the enterprise in the digital economy. Digitalisation, while opening up new opportunities, also significantly increases enterprises' economic and legal security risks. Fraud, cyberattacks and other threats, including legal threats, require companies to develop a comprehensive information and asset protection system.

Thus, introducing digital technologies into the industry is an inevitable process that opens up new business opportunities. The rapid convergence of economic sectors and increased competition will require a constant review of the regulatory framework, especially in ensuring information security and combating cybercrime, digital economy taxation, and consumer protection in the digital environment. However, the security issue, especially in the context of widespread digitalisation, is highly relevant to all businesses, regardless of their industry, and requires further scientific and applied research.

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