# SOCIO-ECONOMIC IMPACTS OF ARTIFICIAL INTELLIGENCE AND DIGITALIZATION IN POST-COVID-19 EUROPE

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*Abstract*: The present article addresses a problem which is an extremely important, relevant, and under-researched topic. As a whole, Europe lags behind China and other technologically advanced countries in the field of artificial intelligence (AI) and digitalization; Bulgaria is among the worst places in the EU in terms of digitalization of the economy. This research contributes to understanding the social and economic significance of digitization and AI in the EU after COVID-19. The emergence of artificial intelligence in the socio-economic landscape of EU member states, coupled with accelerated digitalization, heralds a new era in their development which is anticipated to enhance productivity, innovation, and efficiency. This article aims to study and analyse the theoretical foundations as well as empirical and legal developments concerning the socio-economic effects of Europe's "digital decade" and the applications of AI in a post-pandemic era. SWOT analysis was conducted to pinpoint the strengths, weaknesses, opportunities, and recommendations associated with the use of AI in EU countries. Conclusions and recommendations are provided for implementing suitable state interventions, transforming the pandemic's challenges into growth through new technologies, and helping to achieve a high standard of living in all EU nations.

*Keywords*: Digitalization; Artificial Intelligence; EU; Covid-19; SWOT

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## Introduction

Digitalization has become a top priority for EU member states as a driver of economic growth, job creation, and new business and innovation opportunities. Since 2017, the EU has encouraged the member states and regions to invest more heavily in digital development. Legislation has been adopted, and institutions responsible for this have

been established to provide citizens with a wide range of services. A strong emphasis has been placed on developing digital skills among youth, as connectivity between the state and its citizens will become the new norm for future generations.

Digitalization is transforming many areas of EU countries' social and economic life, such as communication, shopping habits, education, and, last but not least, relations with the state. In recent years, progress has been made in several areas, such as the digitalization of public administration, education, and healthcare. The digital transformation of Europe is essential for maintaining the competitiveness of member state economies at the international level (Marinov, 2020).

The rapid advancement of artificial intelligence (AI) and digitalization has fundamentally transformed the socioeconomic landscape of the European Union, a process that the COVID-19 pandemic dramatically accelerated. This study examines the multifaceted effects of AI and digitalization on the economic development of the 27 EU member states during the post-COVID period, addressing a significant gap in the economic literature, particularly in Bulgarian scholarly discourse. The research objective encompasses the complex interrelationship between AI adoption, digital transformation, and economic outcomes across diverse EU economies in the context of pandemic recovery efforts.

The main research hypothesis posits that digitalization and AI implementation have generated asymmetric socioeconomic impacts across the 27 EU member states, with the degree of positive outcomes contingent upon each country's existing digital infrastructure, regulatory frameworks, and workforce capabilities. Furthermore, we hypothesize that while AI and digitalization offer substantial opportunities for economic growth and enhanced quality of life, they simultaneously pose significant challenges – related to social polarization, market concentration, and labour market disruption – whose mitigation requires targeted policy interventions.

This study employs a multimethodological approach, combining a comprehensive literature review, SWOT analysis, legal framework analysis, and comparative assessment of regional digitalization patterns to examine the complex interplay between technological innovation, economic resilience, and social development. By integrating economic, technological, legal, and social perspectives, we aim to provide a holistic understanding of digitalization processes that moves beyond the technological determinism prevalent in much of the existing literature.

This investigation is significant not just for academic purposes; it tackles a pressing issue for EU policymakers: how to leverage AI and digital technologies to promote economic recovery and sustainable growth while minimizing potential negative effects. By examining regional disparities, sector-specific impacts, and practical policy

frameworks, this research aims to help develop nuanced and contextually relevant digital strategies for different EU member states at their own stages of digital development.

The purpose was achieved by performing the following tasks:

- literature review of the theoretical basis and empirical developments related to the socio-economic effects of Europe's "digital decade" and the application of AI after the pandemic;
- discussion;
- SWOT analysis to identify EU countries' strengths, weaknesses, opportunities, and threats related to AI;
- strategies to increase the positive effects of AI and manage threats in the digital era;
- legal analysis with a focus on human rights risks and AI in a socio-economic context;
- conclusions and recommendations for implementing appropriate state interventions that will turn the pandemic's challenges into growth and help EU countries achieve a high standard of living.

## Literature Review

Several European Commission documents (2017, 2020, 2023) consider artificial intelligence to be one of the main drivers of digital transformation in Europe as well as a significant factor in ensuring the competitiveness of the European economy and a high quality of life. Research and analysis in this regard are extremely relevant at the national and European levels, especially after the COVID-19 pandemic.

The post-industrial digital economy has the potential to change the entire global market. The term "digital economy" indicates a new stage in the production of goods and provision of services using modern information technologies. The question of its development can be considered both theoretically and practically. It is relevant to modern states because digital technologies enhance national strategic competitiveness. This "new economy" is a viable market model with enormous resources that can boost national economic growth and innovation development.

Don Tapscott (1996) describes the problems of the information age and so-called "network intelligence", also defining the "new" economy as a digital economy based mainly on the use of technology. In his book, he focuses on three main areas: the new economy and the factors that shape it, the workings of the internet and its relation to business and governments, and finally the need for strong progressive leadership that

will be responsible for the digital transformation or drive change in this new age.

Artificial intelligence (AI) currently attracts the attention of academics and practitioners due to its role in driving significant changes in EU countries' economies and business environments. With the rapid advancement of digital technologies, AI and digitalization have become crucial for fostering economically and socially responsible progress in business and operations management, transforming member states' economies, and yielding numerous other positive outcomes essential for mitigating the effects of the pandemic.

The economic literature contains numerous studies on the impact of AI and digitalization on the socio-economic life of states and regions in the EU.

A paper by Ilcheva (2021) reviews the current digital transformation process within the social economy, along with perspectives and challenges regarding its future development. The author explores four significant European initiatives that act as drivers of the digital social economy, which are related to the sharing economy, digital labour platforms, digital innovation hubs, and online trading platforms. The paper concludes that the challenges posed by the digital transformation of the social economy are becoming increasingly crucial, particularly regarding investment in digital skills and infrastructure while balancing social impact and value for society.

Kovac et al. (2024) analyse the digitalization process and the digital divide in the European Union and the Western Balkans from 2018 to 2023. They explore the factors causing the digital divide and the digitalizing efforts to guide future research and policy for digital inclusion and sustainable development. By studying a large volume of publications on the topic – a total of 1,119 articles from EU countries and 277 from Western Balkan countries selected for bibliometric analysis – their research reveals a growing interest in issues related to digitalization in the EU. The EU focuses on digital technologies, economic growth, and sustainability, while the Western Balkan countries concentrate on the impact of COVID-19 and digitalization in education and business. Their findings underscore the need for personalized policy approaches to digital inclusion, which are vital for policymakers, researchers, and practitioners working towards global digital development and bridging the digital divide.

Digitalization in the Western Balkans also interests Ördogh (2023), who examines issues related to digitalizing public administrations in these countries. This transition is crucial for replacing the previous multi-stage, paper-based processes with online public administration. Even as Western European countries have been developing their e-government activities for several decades, the comparatively lagging Western Balkan nations have only recently begun to adopt this innovation. In most of the region, the introduction of e-government was linked to the spread of the COVID-19

pandemic, which accelerated the development process. Digital public administration has been increasingly utilized in recent years, experiencing substantial growth particularly during the COVID-19 pandemic when citizens had to learn to adapt to these platforms. The author's research concludes that by establishing coordinating institutions, digitalization will continue to progress appropriately in EU countries, and good practices will be shared across states and regions.

An article by Haq (2024) highlights the crucial role of AI in accounting. The author emphasizes its power and how it has been attracting billions of dollars in investment to reduce business costs and provide innovative solutions. Despite the significant investments required, one of the obstacles faced by regional small and medium-sized enterprises in adopting AI is their lack of necessary resources for effective implementation. Several promising applications are offered by major companies such as Google and Amazon, enabling small and medium-sized enterprises to benefit from technologies which can help accounting professionals perform tasks more efficiently and eliminate repetitive activities. Importantly, machine learning cannot replace the role of accountants. A challenge for firms will be training their workforce to leverage AI effectively. A key conclusion Haq draws is that the benefits of AI in accounting are extensive, including time savings, increased task efficiency, and reduced costs. All these factors enable accountants to concentrate on value-added activities within enterprises, ultimately leading to enhanced work efficiency. Lazarova (2020) examines the role of the accounting information system in a digitalizing company. The report's thesis is that accounting systems are among the first to change rapidly in digitalization and digital transformation. The author claims that the accountant's main functions will be reduced to checking, validating, and authorizing business transactions. Traditional accounting systems will be upgraded with enterprise-wide management systems.

Reese (2019) points out that introducing new technologies is not new. "Artificial intelligence will create millions more jobs than it will destroy," he argues, positing that if people had been asked in the early days of the internet about the impact of connecting billions in a vast network – how communication would transform through emails or how shopping habits would shift towards online platforms – back then, they might have predicted job losses. Analysing these developments from today's viewpoint, Reese recognizes significant shifts in job types and employment, yet highlights the rise of countless innovative companies generating new roles such as web designer, big data expert, and online marketing specialist. To bolster his argument, he discusses the widespread adoption of ATMs, contending that this technology reduced operational costs for banks and enabled them to expand their physical locations. In this light, Reese proposes that AI will likely spawn millions of

jobs and professions that we cannot yet envision.

Tingting (2023) explores how digitalization has transformed the cultural sector in France after COVID-19. Digitalization proved particularly useful during the pandemic in France, as economic, social, and cultural activities during COVID-19 could only continue thanks to technology. The author concludes that technology development will remain an inevitable challenge in response to the pandemic and could lead to a future sustainable restart of the cultural sector. It is essential, however, to rethink infrastructure, accessibility, cultural attractiveness, legal rules, cultural content, data management, health impacts, etc.

Gariba et al. (2024) develop and test a theoretical model to assess the mediating role of technological innovation in the relationship between public digitalization and sustainability within the EU context. Their article emphasizes the significance of promoting technological innovation as a catalyst for public digitalization and a key driver of sustainability progress in the EU. Utilizing a panel data set for EU countries from 2018 to 2023, the study employs structural equation modelling (SEM) to analyse both the direct and indirect effects of public digitalization and technological innovation on sustainability. Its findings reveal that public digitalization positively and significantly influences technological innovation, subsequently promoting sustainability progress. These results offer valuable insights for policymakers and practitioners. There is a need to enhance public sector digitalization across the EU, necessitating policymakers to consider strengthening digital infrastructure, as digitalization can significantly contribute to increased public participation in sustainable decision-making processes.

Pirosca et al. (2021) analyse the impact of AI and digitalization on the future development of the labour market. Assuming that employment faces constant challenges and the labour market continually evolves due to technological trends, they examine the effects of digital skills and internet usage on wages in EU member states. Their findings indicate a strong association between wage levels, digital skills, and internet use. Consistent efforts are necessary to enhance individuals' digital skills to achieve a more efficient and flexible labour market. While digitalization will certainly reduce workloads, it may also lead to greater job insecurity and less influence from employers. Nevertheless, progress and technology are inevitable and can be leveraged to reduce costs, increase profits, and enhance worker incomes.

An article by Luft and Wojtowicz (2023) provides a detailed assessment of the level of digitalization in individual EU countries based on statistical data such as GDP, households with internet access at home, individuals who have used the internet away from home or work, individuals who have never used a computer, individuals ordering goods or services online for personal use, individuals using the internet to

interact with public authorities, and the frequency of internet use and online activities. The aim is to compare and create a ranking of the digitalization levels of EU countries since the pandemic. The analysis results show significant differences in the level of digitalization between Western and Eastern EU countries, stemming from economic, social, and infrastructural disparities. Western countries must continue investing in innovation and education to maintain their technological advantage, while Eastern countries must focus on removing infrastructural and educational barriers. It is important to emphasize that every country, regardless of its current level of digitalization, is taking steps towards modernization and adaptation to the global digital economy.

Klaric (2023) employs a deductive and synthetic research methodology to outline the key aspects of an "intelligent digitalization" policy and explain how its implementation in public services can influence the green transition and social transformation of European society towards sustainable development and enhanced energy independence. The author examines the main components of the integrative approach in deploying digital technologies in public services, including their implementation in central, regional, and local government digital services. A crucial aspect of intelligent digitalization is the promotion of innovative digital services such as "smart cities", "smart government", and "smart administration", which reflect its use as part of various activities within local, regional, and central government structures, facilitating the creation of a common digital platform with a unique perspective. Additionally, harmonizing digital public services is vital to "intelligent digitalization", ensuring the effective and economical operation of public institutions, central and local administrative bodies, and various levels of government. This approach holds significance in the context of the EU's green transformation, which is a key public policy aimed at transitioning the European economy and society towards sustainable development.

Androniceanu and Georgescu (2023) aimed to identify and analyse the progress made by EU administrations regarding digitalization and effective governance during the pandemic period of 2019–2021. Using selected variables from the Eurostat and World Bank databases, the article provides insight into the dynamic changes that occurred in the EU during the period under review. The findings reveal that the Scandinavian countries achieved the most significant and noteworthy increase in digitalization and effective governance in the EU.

The COVID-19 pandemic is also a point of interest for Stefan et al. (2023), who examine economic resilience in EU member states during the pandemic through investigating whether countries where digitalization tools (e-government functions, e-commerce, IT skills, etc.) have been increasingly used in both the public and private

sectors experienced a softer economic decline from 2019 to 2020. The authors have applied statistical correlation analysis to several indicators obtained from Eurostat and the European Commission, developing various regional models with economically and socially homogeneous characteristics among EU member states. These models are based on a hierarchical cluster analysis applied to multiple structural socio-economic and digitalization indicators. The main finding reveals a strong positive correlation between the share of employment in ICT and the share of ICT in GDP, along with the level of people's digital skills and the share of companies with high digitalization intensity.

An article by Milutinović (2022) examines how public policies regarding digital transformation and e-governance have fostered socio-economic cohesion within the European Union and its member states. The author utilizes the Digital Economy and Society Index measurement indicators and e-government benchmarks from 2016 to 2021 in his research. Through data analysis and document content analysis methods, he concludes that the digitalization of the EU single market and public services of member state governments has positively affected economic productivity and sustainability, thereby reducing economic disparities and promoting social development. Consequently, it is evident that digital public policies and e-governance have significantly influenced the economic sector's integration processes, thus enhancing socio-economic cohesion in the European Union and its member states.

Zancajo et al. (2022) analyse the post-pandemic education sector to answer three critical questions about digitalization of the education system, educational inequalities, and teachers' professional development. Although the pandemic impacted all EU countries, research indicates that nations experienced it in different ways influenced by their education systems' characteristics and the primary issues revealed by the crisis. The pandemic appears to have contributed more to redefining policy priorities than introducing new concerns into educational programmes. It renewed focus (and additional public resources) on online teaching, digital technologies, addressing teacher training deficits, and expanding educational opportunities through early childhood education and vocational training. The authors' findings confirm that education systems are complex, multi-layered, and resilient institutions that facilitate gradual change rather than innovative transformations. The pandemic crisis accelerated previously initiated changes (such as digitalization). It highlighted the importance of tackling long-standing issues on the educational agenda, such as educational inequalities and the professional development of teachers.

Artificial intelligence is a research area addressed by Akgun and Greenhow (2022), who describe the potential benefits of AI in supporting student learning and teaching practices while highlighting its ethical and social shortcomings. Identifying and

presenting the ethical challenges of AI in education to teachers and students is crucial. With regard to these issues, they: briefly define AI using the concepts of machine learning and algorithms; introduce AI applications in educational settings, along with the benefits of AI systems for enhancing student learning processes; describe the ethical challenges and dilemmas associated with the use of AI in education; and discuss understanding and teaching about AI by providing recommended learning resources from two institutions – namely, the Massachusetts Institute of Technology (MIT) Media Lab and Code.org. Their aim is to assist practitioners in leveraging the benefits of AI while tackling the ethical challenges of integrating it into K–12 classrooms and presenting learning resources that teachers can use to improve K–12 students' comprehension of AI and ethics.

Manta et al. (2025) examine the interaction between banking efficiency, digitalization, and renewable energy consumption in the EU, focusing on sustainable economic development. Their article explores how digitalization and the banking sector's efficiency have influenced the adoption of renewable energy, considering the EU's environmental and economic priorities. Its methodology includes econometric analysis based on statistical data from EU countries. It utilizes fully modified ordinary least squares (FMOLS) to assess causal relationships between variables, complemented by vector autoregression (VAR) models and Granger causality tests to analyse the dynamic interactions among these variables further. The results indicate a positive correlation between increased digitalization in the banking sector, improved financial performance, and higher investments in renewable energy sources. These factors also aid the transition to a green economy, although their effect varies among EU countries depending on national policies and the existing digital infrastructure. Recommendations for policymakers include stimulating digitalization in the financial sector, creating a regulatory framework to promote green energy investments, and strengthening collaboration between financial institutions and the energy sector to facilitate the transition to renewable energy sources. The article also proposes fiscal policies that favour technological innovation and digitalization to accelerate the adoption of renewable energy.

An article by Crisan et al. (2023) explores the diversity of EU member states regarding labour market digitalization in the post-pandemic context. The article examines indicators that reflect not only the specifics of the labour market but also the degree of digitalization and the impact of the COVID-19 pandemic. The strength of the relationship between digitalization and labour market indicators is quantified using a Pearson correlation test. At the same time, cluster analysis highlights patterns among high-tech EU economies compared to medium- and low-tech ones. Within the high-tech economy cluster, Finland stands out as the EU's leader in digital transformation,

boasting the most digitally skilled workers. On the other hand, the southeastern countries have the greatest need to recover and still lack a practical digital policy framework to support young workers' access to digital training. The practical value of this study lies primarily in guiding decision-makers on which issues to address when implementing EU digital policies.

Rizun et al. (2024) examine the labour market changes due to digitalization and the introduction of AI in the workplace, as well as the structural transformations they have caused in the economy and the nature of work. These changes have significant implications for youth employment, exacerbating the unemployment issue. The article discusses the importance of jobs for new graduates in contemporary society, focusing specifically on the impact of digital technologies and AI. The authors explore the challenges associated with digital transformation and emphasize universities' crucial role in developing the skills necessary for successful employment. The paper also investigates the prospects for graduates in this dynamic environment, which presents challenges and career advancement opportunities. This research may inform guidelines to enhance student preparation for the rapidly evolving labour market.

Artificial intelligence presents an opportunity to create additional employment, as researched by Mladenova (2024). While it can amplify isolation due to a lack of skills and limited labour market access among the poorest in society, innovative applications alternatively facilitate access to training, transform education, and help bridge the gap created by socio-economic disparities, thereby infusing new labour into the economy. AI can serve as a means to escape the poverty trap and act as a catalyst in economic transformation. This approach can also address the problem of labour shortages in specific sectors, such as construction.

A study by Nikolopoulou (2022) provides evidence of students' mobile phone usage for academic purposes and contributes to the discussion on the post-pandemic digitalization of universities. The article surveyed 60 students at a Greek university, gathering data through an open-ended questionnaire and employing descriptive content analysis to examine the quantitative data. The findings reveal that students primarily use their mobile phones for information retrieval (e.g., assignments, videos, images, graphs, simulations, online dictionaries, and scientific articles), quick access to e-classes (e.g., learning materials/slides), and faculty websites, as well as communication with peers (e.g., inquiries, sharing educational resources) and teachers. While engaging in mobile practices, students experience advantages (easy and quick searches, flexibility, familiarity with digital technologies) and disadvantages (internet connectivity issues, unreliable sources of information, distraction). Additionally, the article discusses implications for students, teachers, and university policymakers, emphasizing their role in reshaping digitalization. In conclusion, mobile learning can potentially enhance

universities' digitalization, thereby affecting the sustainability of education in the post-pandemic era.

Todorova (2020) explores the impact of "narrow artificial intelligence", a prevailing reality, on transformative processes. This development may result in losing certain jobs while generating new ones. The article outlines optimistic and pessimistic scenarios and examines the arguments in the ongoing debate. Additionally, it highlights potential risks associated with implementing AI across different areas of human activity.

A report by Anachkov (2024) analyses the impact of AI in credit risk management within the banking sector. The research concludes that many challenges encountered when using traditional methods for credit risk management can be addressed by applying artificial intelligence. Introducing AI in credit risk assessment enables banks to enhance forecasting accuracy, identify patterns and anomalies that may not be noticeable with traditional methods, and make more informed decisions about borrowers, particularly those with limited credit histories. Furthermore, AI-based algorithms can continuously learn and adapt to new data, allowing banks to refine their models over time and manage credit risk more effectively in today's dynamic and data-rich environment. Although the challenges associated with AI implementation can be met, it is crucial not to rush into full integration without first thoroughly testing, validating, and incorporating the models into existing processes, as poor preparation and hasty conclusions can result in suboptimal outcomes and, ultimately, erroneous decisions for the bank.

Acemoglu and Restrepo (2018) examine the effects of automation and AI on labour demand, wages, and employment. They highlight the displacement effect created as machines and AI replace human labour in tasks previously performed by workers. This displacement effect results in a reduction in labour demand and wages. However, it is counteracted by the productivity effect generated from the cost savings of automation, which increases labour demand in non-automated tasks. The productivity effect is further bolstered by capital accumulation and deepening automation (improvements to existing machines), which elevate labour demand. Despite these offsetting effects, they remain incomplete. Even when strong, automation enhances worker productivity more than it raises wages and reduces the labour share of national income. A significant counteracting force against automation is the creation of new labour-intensive tasks, which reintegrates labour into new activities and tends to elevate the labour share, counterbalancing the impact of automation. The article also underscores the limitations and imperfections that impede economic and labour market adaptation to automation, weakening the productivity gains from this transformation: for example, a mismatch between the skill requirements of new technologies and the introduction of automation at an excessive rate, possibly at the

expense of other productivity-enhancing technologies.

Frătică-Dragomir (2024) examines the pension systems of four European countries – Lithuania, Latvia, Estonia, and Romania – providing a comprehensive analysis of their respective structures, digitalization efforts, and the potential for utilizing AI for public benefit. The author highlights the differing approaches to pension systems and digitalization strategies across these nations. The potential of AI and technology to drive progress in the public sector is presented, ultimately enhancing well-being for citizens and government efficiency. The four national systems are compared to understand Romania's position in the Eastern European landscape. In Romania, digitalization is a complex evolutionary process aimed at improving access to e-services, enhancing the quality of information and communication technologies, and ensuring that all institutions have opportunities to interact in multiple ways with citizens, as well as with the business environment and other central and local public institutions, serving as a measure for optimization and de-bureaucratization.

Cao (2024) explores the impact of the digital economy on sustainable development, analyses its associated challenges, and investigates the potential opportunities for sustainable development within the current digital economy. First, the author delineates the digital economy's definition, scope, and developmental trends. Then the application of the digital economy across various fields is examined in detail, revealing its potential value in social, economic, and environmental aspects. However, the rise of the digital economy has also given rise to a series of environmental, social, and economic challenges, such as e-waste, the digital divide, structural changes in employment, and inequality. The article highlights the digital economy's opportunities for sustainable development by promoting environmental sustainability, social inclusion, and economic innovation. Through innovations in digital technology, environmental issues are addressed more effectively, socially inclusive growth is achieved, and economic innovation is stimulated. The article emphasizes the positive interaction between the digital economy and sustainable urban development through case studies. It concludes with a perspective on future trends in the digital economy and provides recommendations for integrating sustainable development concepts to ensure that the digital economy becomes a powerful driver of sustainable development.

Manaf (2024) aims to identify the main characteristics of the relationship between the green and digital economies. To obtain accurate results, the ultimate goals of the green economy are first identified, followed by an analysis of the digital economy. The digital economy offers practical options for producing and pricing natural resources, establishing ecological values in economic interactions, and assessing carbon footprints. The digitalization of economic activities is crucial for greening the economy, which can politically facilitate the formation of a new regime of capital accumulation. Analysing

this interaction in the article will assist in drafting practical recommendations for addressing long-term challenges.

Champos et al. (2025) present a comprehensive risk management framework for developing “frontier AI” by integrating established risk management principles with emerging AI-specific practices. The framework consists of four key components: (1) risk identification through literature review, red-teaming, and risk modelling; (2) risk analysis and assessment using quantitative metrics and clearly defined thresholds; (3) risk treatment via mitigation measures such as containment, deployment controls, and assurance processes; and (4) risk governance that establishes clear organisational structures and accountability. Drawing on best practices in mature industries such as aviation and nuclear energy while addressing the unique challenges of AI, this framework offers AI developers actionable guidance for implementing robust risk management. The paper details how each component should be executed throughout an AI system’s lifecycle, from planning to deployment. It emphasizes the importance and feasibility of conducting risk management work before final training to minimize the associated burden.

An article by Chopra and Sharma (2021) reviews 148 studies using neural and hybrid-neuro techniques for stock market forecasting, categorized based on 43 automatically coded themes obtained with NVivo 12 software. They group the studied articles into two main categories: research characteristics and model characteristics. Research characteristics are further divided into the covered stock market, input data, and nature of research, while model characteristics are classified into data preprocessing, AI techniques, training algorithms, and performance measures. The findings highlight that AI techniques can effectively study and analyse stock market activity. In their conclusion, the authors establish a research agenda for potential financial market analysts, artificial intelligence, and soft computing scholars.

A report by BAS, the Bulgarian Academy of Sciences (2020), regards AI as one of the primary drivers of digital transformation in Europe and a crucial factor in ensuring the competitiveness of the European economy and a high quality of life. It outlines the specific aspects of the European vision for creating "trustworthy AI", in which technological progress is paired with a legal and ethical framework to ensure the security and rights of consumers, along with measures for collecting accessible, high-quality data, widespread information dissemination, and equal access to the benefits of AI technologies. An analysis of the mutual influence of AI development, economic growth, and quality of life is conducted, highlighting the specifics of the three main types of sectors related to the creation and use of AI: those developing AI, consuming AI, and establishing conditions for the development and implementation of AI. The main prerequisites and challenges for the development of AI in Bulgaria from 2020 to

2030 are also presented. Finally, a review of the existing strategies and projects for Bulgaria's growth in the coming years is undertaken, focusing on documents related to the "Digital Bulgaria" programme for 2021–2025.

## Discussion

Artificial intelligence (AI) and the digital economy are closely intertwined and significantly impact each other. At the European level, AI is a component of the "Digital Europe" programme, which between 2021 and 2027 aims to implement a digital transformation in the EU with maximum benefit for enterprises, public administrations, and society, including digital identity. Through many different channels, AI is impacting economic growth and employment[1] and can influence global economic growth through its widespread adoption and diffusion. A mathematical analysis examining how AI influences economic growth reveals that economic growth is a distinct factor of production. Simulations demonstrate that investment in AI lowers the cost of capital, raises wages, and increases productivity. Models based on production tasks show that AI increases labour share and wages by generating new activities. These findings have economic policy implications. A recent study by the World Economic Forum finds that AI is expected to contribute up to $15.7 trillion to the global economy by 2030. As this technology develops, it will likely play an even more important role in the digital economy. Businesses that can harness the power of AI will be well-positioned to succeed in the future. The importance of digitization and AI began accelerating precisely due to the COVID-19 pandemic. Therefore, it is important to focus on the digital-economy–artificial-intelligence–economic-growth nexus to assess the socio-economic implications of their application and development.

Predictive models based on elements of AI can be used as a fundamental technique in developing and diffusing innovations in the digital environment, generating sustainable economic growth and reducing investment risk. Artificial-intelligence-based technologies, such as machine learning and robotic process automation, can automate repetitive tasks and improve efficiency in various digital economy sectors. They can analyse large volumes of data to extract valuable information needed by investors and analysts. AI allows businesses to customize their products and services based on customer preferences and behaviour. This is a significant topic to explore, as EU member states can use the potential of new technologies in pursuit of economic development while addressing new challenges in the post-pandemic world. The COVID-19 crisis accelerated digitalization in Europe and imposed new models of

[1]https://www.weforum.org/stories/2025/01/four-ways-to-enhance-human-ai-collaboration-in-the-workplace/

work and economic activity. This has led to a significant increase in the importance of AI and the digital economy as key drivers of economic recovery and growth. AI and the digital transformation are key technologies to increase European economic productivity, innovation, and competitiveness. They offer new opportunities for businesses and society while posing security, ethical, and employment challenges. In the post-pandemic world, a balance must be found between fostering technological innovation and economic development while protecting public interests such as data privacy and social justice. This is the basis of the new trilemma, which requires a careful approach to regulations. The EU is working to build a Digital Single Market and, with the Artificial Intelligence Act, has already launched a regulatory framework for AI to support innovation while protecting European values. Studying this trilemma helps us understand legislative measures and strategies for balanced economic development. Historically, AI systems have developed in three directions: information processing systems, logical structures, and learning systems. The first direction is known as neural networks. Thus far, information-based systems have been the most successful.

From a scientific perspective, AI is a field of study that seeks to explain and reproduce intelligent behaviour through computer processes. Some researchers even advocate for the so-called physical symbol hypothesis (see Newell & Simon, 1976). This hypothesis asserts that intelligence is a functional quality of specific symbolic algorithms and is independent of any physical form.

The theoretical and empirical literature sources reviewed in this paper can be divided into those supporting the role of AI and digitalization in the socio-economic development of EU countries and those criticizing their impact and the development of digitalization within these countries. Additionally, some studies adopt an intermediate position, recognizing both the positive and negative aspects of digitalization processes and the application of AI.

Authors who believe that the process of digitalization and the application of AI in the socio-economic life of EU countries are essential for their development include Ördogh (2023), Haq (2024), Tingting (2023), Gariba et al. (2024), Klaric (2023), Androniceanu and Georgescu (2023), Stefan et al. (2023), Milutinović (2022), Akgun & Greenhow (2022), Manta et al. (2025), Mladenova (2024), Nikolopoulou (2022), Cao (2024), Reese (2019), Chopra and Sharma (2021), Champos et al. (2025), Frătică-Dragomir (2024), and BAS (2020).

Critics of digitalization and the application of AI include Kovac et al. (2024), Luft and Wojtowicz (2023), Rizun et al. (2024), Todorova (2020), and Acemoglu and

Restrepo (2018).

Literature sources that are rather neutral and see both positive and negative aspects in the process of digitalization and AI in European countries include Ilcheva (2020), Lazarova (2020), Pirosca et al. (2021), Zancajo et al. (2022), Crisan et al. (2023), Anachkov (2024), and Manaf (2024).

Theoretical studies are those of Gariba et al. (2024), Zancajo et al. (2022), Rizun et al. (2024), Todorova (2020), Reese (2019), Chopra and Sharma (2021), Champos et al. (2025), Frătică-Dragomir (2024), and BAS (2020).

Empirical studies on AI and digitalization include works by Luft and Wojtowicz (2023), Klaric (2023), Androniceanu and Georgescu (2023), Stefan et al. (2023), Milutinović (2022), Manta et al. (2025), Crisan et al. (2023), Nikolopoulou (2022), Anachkov (2024), Cao (2024), and Champos et al. (2025).

The above systematization of literature sources indicates that the process of digitalization and the role of AI are widely debated topics among scientists. Many authors address the application of AI in labour and education, while others focus on creating a high standard of living in EU countries. It has relevance for stock exchanges, market efficiency, and risk management purposes, as AI can help predict market changes and facilitate informed investment decisions. However, many authors believe that to utilize its potential fully, it is crucial to establish clear principles, guidelines, and regulations to ensure the ethical and responsible use of technology in various areas of life and business.

The literature review's analysis reveals that AI, when applied appropriately, can drive economic growth in EU countries. Its transformative potential sets the stage for shifts in productivity standards, employment patterns, and the trajectory of economic progress. Its increasing impact goes beyond task automation, ushering in a new age of innovation, efficiency, and competitive strategy.

## SWOT Analysis of AI Application in EU Countries

The application of AI is based on the rational behaviour of economic actors; however, this idea allows for all fundamental economic concepts and theories to be reinterpreted (Marwala & Hurwitz, 2017). This notably relates to the theory of supply and demand, rational choice, rational expectations, the notion of bounded rationality, asymmetric information, pricing, game theory, the development of economic mechanisms, the financial theory of profit and loss assessment (prospect theory), the efficient market hypothesis, portfolio theory, counterfactual theory, quantitative finance, and causal relationships in economics, among others.

The use of AI systems is thought to affect the economy primarily through the efficiency of market mechanisms (Hetemäki, 2018). Two interrelated effects on the economy can be observed. First, AI systems improve the possibility of making rational decisions regarding demand (consumption) and production. On the other hand, due to market imperfections and particularly asymmetric information, the adverse effects of market distortions may increase. This impacts financial markets, high-frequency trading, and the labour market by shifting the focus in some cases from cognitive skill requirements (taken over by AI) to non-cognitive skills, making educational attainment a less valuable indicator of labour utility. Simultaneously, we also observe the opposite trend of replacing routine operations.

One of the most significant consequences of implementing AI programmes is modifying the pricing process, which lies at the core of decentralized market exchanges. Software in this field has evolved from rule-based systems to reinforcement learning programmes. These are much more autonomous than their predecessors. Driven by AI, they develop the pricing strategies of exchange participants from the ground up, engaging in active experimentation and adapting to the changing environment. This learning process requires minimal external guidance (for more details, see Calvano et al., 2019).

The proliferation and evolution of pricing algorithms raise various questions about the competitive structure of markets (Harrington, 2017). In particular, as several researchers have noted, there are concerns that reinforcement learning algorithms can tacitly negotiate, meaning they can communicate with one another without being explicitly instructed to cooperate, thereby entering into implicit agreements to coordinate pricing policies rather than compete. Although no antitrust case has been brought against autonomous secret algorithms, antitrust agencies are seriously considering this issue. Moreover, the recent wave of consumer discontent in Southeastern Europe can be partially attributed to this pricing practice employed by major retail chains.

The integration of AI into the economies of EU countries marks a new growth stage characterized by heightened productivity, innovation, and efficiency. While adopting AI can create substantial opportunities for advancement and creativity, it also presents challenges and risks.

Table 1 presents a SWOT analysis of the strengths, weaknesses, opportunities, and threats associated with using AI in the socio-economic landscape of EU states. This analysis aims to determine whether the benefits of utilization exceed the drawbacks for these countries and if the opportunities surpass the threats.

Table 1. SWOT Analysis of Strengths, Weaknesses, Opportunities, and Threats Associated with the Application of AI in EU Countries

| ***Strength*** | ***Weaknesses*** |
|---|---|
| - Elimination of repetitive tasks;<br>- Time-saving;<br>- Execution of complex tasks;<br>- Cost reduction;<br>- Maximum accuracy;<br>- Working with "big data";<br>- New highly skilled jobs;<br>- Improved labour productivity;<br>- High efficiency;<br>- Greater precision;<br>- More memory;<br>- Multilingual communication;<br>- Faster speed of work. | - Need for large investments for its use in a working environment;<br>- Digital divide of society;<br>- Structural changes in employment;<br>- Lack of out-of-the-box thinking;<br>- Cannot replace communication, connection with people and team management;<br>- Lack of clear ethical standards – lack of clear regulations can lead to misuse of AI, especially in sensitive areas such as surveillance and decision making;<br>- Dependence on technology – over-reliance on AI can lead to loss of traditional skills and knowledge;<br>- Inadequate workforce training – many workers lack the necessary digital skills, making it difficult to implement AI;<br>- High maintenance costs – maintaining AI systems requires significant financial and technical resources. |
| ***Opportunities*** | ***Threats*** |
| - New skills and competencies among employees;<br>- Development in the field of technology;<br>- Solving environmental problems;<br>- Potential for innovation and growth;<br>- Introduction of new professions;<br>- Stimulating economic innovation;<br>- Opportunity to enter new markets/ find new customers/ improve products;<br>- Improving access to education and healthcare;<br>- Personalization of services and products;<br>- Enhanced quality of life;<br>- Increased motivation and satisfaction. | - Can make people lazy;<br>- Danger of the disappearance of some traditional professions and job losses;<br>- Loss of social sensitivity;<br>- De-socialization;<br>- Blurring and shifting personal responsibility;<br>- Electronic waste;<br>- Increase of social polarization – AI can increase the gap between rich and poor if access to technology is not evenly distributed;<br>- Implicit oligopoly in markets;<br>- Huge energy consumption;<br>- Risk of loss of control – autonomous AI systems can be difficult to control, which can lead to unintended consequences;<br>- Loss of human sovereignty;<br>- Cyber threats – AI deployment may increase the risk of cyber-attacks and misuse of personal data;<br>- Energy dependence – AI systems require a significant amount of energy, which can increase the strain on energy resources. |

*Source*: Prepared by the authors.

From a theoretical point of view, the potential impact of AI on economic growth can be expressed by slowed down or even negative rates, a return to the relatively stable rates of economic growth characteristic of the period of the Industrial Revolution, continuous acceleration over time, and infinite growth for a limited time. The final stage of the impact of AI on the economy and society is the so-called singularity. In other words, the singularity is the stage where a machine will have enough intelligence to redesign itself to improve its intelligence. There are many channels through which AI can impact economic growth and employment. Theoretical models show this impact to be significant,

as adopting AI technology increases productivity and lowers labour costs and prices. AI can influence global economic growth through its widespread adoption and diffusion. A mathematical study of the effects of AI on economic growth shows that the latter is unique as a factor of production. Simons, Turrini, and Vivian (2024) state that AI could also have a highly disruptive effect on the economy and society. They warn that this could create super-firms (centres of wealth and knowledge) with potentially disastrous economic consequences. It may also widen the gap between developed and developing countries and increase the need for workers with specific skills while making others redundant; this latest trend could have far-reaching implications for the labour market. Experts also warn of its potential to increase inequality, reduce wages, and shrink the tax base. Concerning the above, however, it is necessary to pay attention to the ethical and regulatory challenges raised by the rapid advancement of AI in the digital economy. Issues such as data privacy, algorithmic bias, and the impact of AI on employment must be addressed to ensure responsible and inclusive adoption of AI. Prominent researchers of international standing put the AI issue squarely by stating that we are at the beginning of the AI era. Frameworks and regulations should thus be carefully developed to govern the use of AI in the digital economy.

The strengths of using AI include saving time, executing complex and repetitive tasks, reducing costs, working with "big data", increasing memory capacity and precision, achieving a faster speed of work with maximum accuracy, improving labour productivity, and enhancing job efficiency. Routine and repetitive tasks, such as data entry, processing primary documents, and registration, can be automated with unprecedented accuracy. This frees up valuable time and reduces the risk of human error, ensuring higher work quality. The ability of AI to process and analyse data on an unprecedented scale and at unprecedented speeds enables significant advances in sectors such as healthcare, ecology, and autonomous systems. In healthcare, for instance, innovative applications transform patient care, drug discovery, and disease detection, providing faster, more accurate diagnoses. Ecology is another area where innovations are making significant progress, such as AI tools for monitoring climate change, managing natural resources more efficiently, and predicting environmental disasters.

The weaknesses of implementing AI include the potential loss of traditional jobs, the digital divide across society, a lack of innovative thinking, the necessity for substantial investments, and various ethical considerations. The ethical deployment of AI, especially in sensitive areas such as surveillance and decision-making, requires thorough research and debate (Tegmark, 2018). While professions involving automation and routine tasks are at risk, AI has the potential to create employment in numerous new fields that necessitate specialized skills for the design, programming, and maintenance of AI systems, thereby establishing a new employment structure. Digital disparities primarily

relate to age demographics and levels of education, and these will be felt in both developed and developing countries due to the influence of tools such as ChatGPT, Bing AI, and Google Bard.

Some of the threats associated with AI include making people lazy, the disappearance of certain professions, and job losses. A study by the OECD (2019) reports that 14% of jobs are at high risk of automation, while another 32% will be radically transformed in the next 15 years. Simultaneously, many workers no longer possess the necessary skills to perform the new tasks brought on by digitalization. This leads to the conclusion that low-skilled workers are most at risk due to the nature of their tasks, which can be easily automated. In addition to the risk of being replaced by new technologies, workers are leaving certain professions due to pay-related issues. Other threats include the loss of human sovereignty, decreased social sensitivity, data protection problems, an increasing trend of de-socialization, and the blurring and shifting of personal responsibility.

The opportunities opened up to EU countries through AI are substantial, including the discovery of new professional pathways associated with the development of innovative digital technologies, which can mitigate the effects of the disappearance or limitation of certain professions. Specialists are expected to be increasingly in demand, particularly in areas like solar technologies, renewable energy, digital content management, telesurgery, telepharmacy, and more. The demand for digital literacy, complex problem-solving skills, and workforce adaptability will rise as AI integrates into various sectors. This evolution demands rethinking education and training systems to prepare individuals with the necessary skills for an AI-driven economy. Other applications of AI include stimulating innovation, accessing new markets, reaching new customers, enhancing products, advancing technology, and boosting motivation and satisfaction. AI fosters innovation by enabling the creation of new products, services, and business models. Its contribution to economic growth is considerable, promising a future of enhanced productivity, innovation, and human capital development. All these examples highlight the potential for AI to achieve new levels of innovation and growth.

Our SWOT analysis indicates that AI offers numerous advantages and opportunities for EU countries, such as addressing economic inequalities and fostering fairer, more equitable conditions for economic participation. Data processing speed and quality improvements, enhanced security and transparency, and more efficient process management are just a few of the expected benefits. Creating new jobs and optimizing labour processes are just the start of changes to come through this integration. Ethically implementing artificial intelligence is essential to ensure fairness and trust within the system. It is vital to prioritize transparency and ethical practices to facilitate the development of a more equitable and inclusive economic environment in which all participants have equal opportunities for growth and success. This development would

contribute to sustainable growth and overall societal well-being, generating new opportunities for efficiency, innovation, and sustainability.

Economic, neoclassical, endogenous, and evolutionary growth theories agree that technological change is decisive in economic growth. Endogenous growth theory emphasizes the role of technological change as an essential economic growth generator. Some research suggests that micro-level business performance is enhanced by digital transformation processes that drive economic growth. Internet access and the development of mobile applications allow companies to adapt more quickly to turbulent economic conditions, including new consumer expectations. For this reason, digital transformation is becoming an essential element of business development strategies. According to the above SWOT analysis, we constructed four strategies in Table 2.

Table 2. Strategies Based on the Applied SWOT Analysis

| ***Mini-mini (Survival Strategy)*** | ***Maxi-maxi (Growth Strategy)*** | ***Mini-maxi (Overcoming Threats Using Opportunities)*** | ***Maxi-mini (Overcoming Weaknesses Using Strengths)*** |
|---|---|---|---|
| *Mitigating the Digital Divide*:<br>- Advocating for increased investment in digital education and enhancing the accessibility of AI technologies to address the disparities encountered among diverse socio-economic groups.<br>*Limiting Social Polarization*:<br>- Promoting socially-oriented AI initiatives that foster community engagement and mitigate the risk of dehumanization.<br>*Control over AI and Ethical Standards:*<br>- Formulating robust regulatory frameworks to prevent market monopolization while ensuring the responsible utilization of AI.<br>*Mitigating Employment Displacement*:<br>- Implementing comprehensive reskilling and upskilling programmes for workers to effectively navigate the evolving labour market. | *High-Precision Innovation Strategy:*<br>- The advancement of novel technologies and innovations involves the utilization of high efficiency, precision, and big data capabilities in the creation of new products and services.<br>*Enhancing the quality of life*:<br>- Implementing automation of routine tasks and personalizing services to improve healthcare, education, and public services.<br>*Promoting Economic Growth*:<br>- Investing in AI to generate employment opportunities and enhance productivity.<br>*Engaging in New Markets*:<br>- The processes of digitalization and multilingual communication facilitate the international expansion of European enterprises. | *Developing Artificial Intelligence for Sustainability*:<br>- Implementing AI technologies to confront environmental challenges and mitigate the impact of electronic waste.<br>*Ethical and Legal Frameworks*:<br>- Establishing regulations that guarantee the safe and equitable integration of AI into societal structures.<br>*Leveraging AI as a Tool for Social Development*:<br>- Employing AI to foster personalized education, enhance healthcare delivery, and improve accessibility to public services.<br>*Managing the Automation of Professions*:<br>- Formulating AI solutions that augment human labour rather than wholly supplanting it. | *Investing in Digital Infrastructure*:<br>- Utilizing AI to enhance access to digital services in underserved regions.<br>*Automation and Job Creation*:<br>- Integrating AI solutions with workforce retraining programmes to alleviate adverse effects on employment.<br>*Enhancing Data Security*:<br>- Employing AI technologies for cybersecurity measures and protecting personal data.<br>*Efficient Resource Management*:<br>- AI's role in cost reduction through the optimization of energy consumption and the promotion of sustainable resource utilization. |

*Source*: Prepared by the authors.

## Legal Aspects of the Socio-Economic Impact of Artificial Intelligence in Post-Pandemic Europe

Digitalization and artificial intelligence processes bring new perspectives to the European socio-economic landscape (Sevag Kertechian & El-Farr, 2024) following the COVID-19 pandemic. Europe is still in a recovery phase. During the pandemic, it sought ways to minimize social contact and the spread of the virus, leading to the exploration of innovative solutions and technologies to tackle socio-economic problems. These technologies present significant advantages; however, they also introduce several challenges that require the legal framework (Regulation [EU] 2024/1689) to align with new social relations. In this part of the study, we will examine the legal aspects of the socio-economic impact of AI in post-pandemic Europe, focusing on key areas where the need for legal regulation of social relations linked to AI becomes evident, such as human rights, citizens' labour rights, data protection, and liability resulting from the unregulated use of technology.

At the EU level, the essential need to create legal regulations on the use of AI was felt relatively early. Coding initiatives were undertaken immediately after its introduction into the free market, which bore fruit in April 2021. The European Commission proposed new rules and actions to establish the EU as a global centre for trustworthy artificial intelligence. The EU became a pioneer in creating a legal framework for AI and created the conditions for drafting a coordinated plan with the member states to ensure citizens' and businesses' safety and fundamental rights while stimulating investment and innovation in AI across the EU. On 10 February 2025, the European capital, Paris, became a centre for discussing serious decisions in the field of AI. Nearly 100 countries, including the USA and China, participated in the international forum. EU legislation has recognized both the pros and cons; therefore, in its legislative framework, the EU did not fail to classify AI systems based on their associated levels of risk. Four levels have been defined: minimal, limited, high, and unacceptable risk. The approach taken to create a legal framework was also not accidental. The Artificial Intelligence Act (AI Act) provides for human-centric, human rights-based, and trustworthy AI. It determines that systems threatening people’s safety, livelihoods, and human rights, such as "social scoring" by governments, are prohibited. Such systems are categorized as unacceptable risk and cannot be placed in the EU market. Article 5 of Regulation 2024/1689 prohibits the introduction of AI systems or AI models that use the following practices:

- subliminal, manipulative, or deceptive techniques that would influence a person's decision-making process;
- the vulnerability of a person due to age, illness, disability, or socio-economic status to influence their behaviour in a way that would cause them serious harm;

- assessing or classifying people based on their social behaviour or personal characteristics, leading to unfair or disproportionate disadvantage in different social contexts;
- for the sole purpose of assessing a person's risk of committing a crime based on profiling or personal characteristics, unless it supports a human assessment based on objective and verifiable facts;
- creating or expanding facial recognition databases via the untargeted extraction of facial images from the internet or video surveillance footage;
- reading people's emotions in the workplace or educational institutions, unless for medical or safety-related purposes;
- biometrically categorizing people to infer their race, political views, religious beliefs, or sexual orientation, unless it is applied to lawfully acquired data or for law enforcement purposes, including real-time remote biometric identification in publicly accessible places.

Article 6 of the Regulation sets out the rules for determining an AI system or AI model as high-risk. These include AI systems used in critical infrastructures (e.g., transport) and educational or professional environments that may affect people's lives and work (e.g., exam marking). This classification requires a risk management system (Article 9), must be accompanied by specific technical documentation, and must preserve the human factor in the form of appropriate tools for human–machine interfacing. Along with high-risk AI, there are also AI systems with specific transparency obligations, such as chatbots, where users must be informed that they are interacting with a machine. All other AI systems that pose minimal or no risk to the rights or safety of citizens are categorized as low-risk. To ensure the new rules' effective implementation, it has been proposed for nationally competent market surveillance authorities to supervise and together establish a European Artificial Intelligence Council to facilitate their implementation and stimulate the development of AI standards.

## Protecting Fundamental Rights in the Age of AI

The introduction of AI in various industries has led to the automation of specific tasks, which can lead to job losses, especially in repetitive and routine activities (Rodrigues, 2020). This creates a need to adapt legislation to guarantee workers' rights and to encourage retraining and upskilling. The European Union recognizes these challenges and is taking steps to adapt to the new realities, for example, with labour laws. This includes promoting training and retraining programmes and developing policies to protect workers in the context of increasing automation. On the other hand, protecting the right to privacy is also guaranteed through the prism of personal data protection by the General Data Protection Regulation (GDPR), which restricts the collection and

processing of personal data and automated decision making. Artificial intelligence systems often rely on large volumes of data, including personal data, to function effectively. This raises questions about data protection and privacy. In the European Union, the GDPR provides a strict framework for processing personal data, including by AI systems. It requires organisations to obtain consent from individuals before processing their data, provide transparency about data use, and guarantee individuals' right to access, rectify, or delete their data. These requirements are essential when developing and deploying AI systems to ensure they respect individuals' rights and protect privacy. Human rights in terms of protection from discrimination can be violated through algorithmic bias, which can lead to the denial of loans or employment based on ethnicity, gender, or social status. This is why AI regulations are in the spirit of prohibiting the use of AI for discriminatory credit scoring or personnel selection. Another possible risk hypothesis could be related to the right to informed consent when companies introduce a requirement to disclose to users that they are interacting with AI and not with a human. This covert use of chatbots or virtual assistants can mislead people and influence their decisions.

Table 3. Comparison of Human Rights Risks with AI in a Socio-Economic Context

| Legal aspect | Human rights risks | Risks associated with AI | Opportunities to overcome risks |
|---|---|---|---|
| **Employment and labour market** | Automation can lead to job losses. | Unfair treatment in AI recruitment. | Retraining and training programmes for new AI-related professions. |
| **Economic inequality** | AI can concentrate wealth in the hands of a small group of people. | Lack of access to AI technologies for poorer regions | Introducing fair taxation for AI-based businesses and creating a universal basic income. |
| **Access to information** | AI algorithms can filter content and create "echo chambers". | Censorship or disinformation targeting certain groups. | Regulations for algorithmic transparency and promotion of media literacy. |
| **Justice and security** | Incorrect or biased AI systems in law enforcement can lead to unfair convictions. | Unethical use of biometric data by governments. | Independent oversight of the use of AI in the judicial system and algorithmic justice. |

*Source*: Prepared by the authors.

As a result of the above analysis, it is clear that protecting human rights in the context of AI requires strong regulation, transparency, and ethical development of technologies to minimize socio-economic risks. With the increasing use of AI, questions arise about the liability of AI systems when it comes to decision-making. For example, in an autonomous vehicle accident, who is at fault: the manufacturer, the software developer, or the vehicle owner? These questions require clearly defined legal liability frameworks. The European Union is working on adapting existing

liability laws to cover the specific challenges associated with AI. This includes addressing issues such as the predictability of actions within AI systems, the explainability of decisions made by AI, and compensation mechanisms for damages caused by AI.

The rise of artificial intelligence (AI) in post-pandemic Europe raises significant opportunities and serious legal challenges related to the socio-economic rights of citizens. While AI contributes to automation, economic growth, and optimization in various industries, it simultaneously calls into question personal data protection, non-discriminatory access to resources, and social inequality. Legal frameworks in the European Union, such as the GDPR and the forthcoming AI Act, aim to ensure transparency and ethical use and prevent abuse. Key risks, such as biased algorithms, unlawful profiling, digital surveillance, and job losses due to automation, necessitate strict checks and balances between technological progress and the protection of fundamental human rights. Particular attention should be paid to the economic consequences of the deployment of AI, from the potential widening of the gap between high- and low-skilled workers to the need for new regulations on the taxation of automated labour. In this context, the European Union can impose policies on retraining, social protection, and universal basic income to compensate for adverse effects. Additionally, protecting the right to informed consent and preventing manipulative or subliminal techniques used by AI is crucial. To minimize the risk of society being controlled through algorithms, it is necessary to introduce independent audits, transparency in the operation of systems, and legal liability mechanisms in case of violations. In conclusion, the socio-economic impact of AI in Europe requires a comprehensive legal approach that balances innovation with human rights. Regulations must minimize risks and create conditions for a fair distribution of the benefits of AI, ensuring both economic stability and the protection of civil liberties.

## Conclusion

Our comprehensive analysis of artificial intelligence and digitalization in EU member states reveals a complex landscape of opportunities, challenges, and regional disparities. The research findings largely support our initial hypothesis that digitalization and AI generate asymmetric socioeconomic impacts across the EU, with outcomes heavily influenced by pre-existing digital infrastructure, regulatory capabilities, and workforce readiness.

The study has revealed notable geographical differences in digitalization levels, highlighting a distinct East–West digital divide. Scandinavian countries stand out as leaders in digital transformation and e-governance effectiveness, whereas countries in

Southeastern Europe continue to struggle with developing digital infrastructure and adapting their workforce. This gap has serious implications for economic resilience, as our analysis demonstrates a strong positive correlation between digitalization intensity – assessed in terms of the ICT employment share, ICT's contribution to GDP, and digital skills in the population – and economic stability during the pandemic's disruption.

Our SWOT analysis indicates that although AI presents various strengths (increased productivity, reduced costs, optimized processes) and opportunities (tech innovation, tailored services, solutions for environmental issues), these advantages are tempered by significant weaknesses (high investment demands, digital disparities, workforce displacement) and threats (social isolation, cybersecurity vulnerabilities, market concentration). These insights highlight the need for nuanced policy strategies that enhance benefits while carefully tackling possible negative side effects.

Our analysis of sector-specific effects has identified three clear categories associated with AI development: sectors creating AI technologies, sectors utilizing AI applications, and sectors shaping the conditions for AI implementation. The growth dynamics within these categories vary substantially by each member state, with more economically advanced regions typically demonstrating a stronger ability to produce and successfully integrate AI technologies into their existing economic frameworks.

The COVID-19 pandemic largely accelerated existing digital transformation trends rather than establishing entirely new technological paths. The crisis and its aftermath have shifted policy focus and resources towards digital infrastructure, online service delivery, and the development of digital skills in the workforce. Educational institutions, healthcare systems, and public administration have undergone notable digital transformations, though success and sustainability vary among different member states.

In the labour market, our analysis has made a notable link between wage levels, digital skills proficiency, and internet usage patterns. Workers with low skills are particularly vulnerable to automation, with around 14% of jobs at a high risk of being displaced and an additional 32% likely to face significant changes. This highlights the critical need for comprehensive reskilling and upskilling initiatives targeting at-risk workforce segments to prevent worsening existing socioeconomic inequalities.

The EU's groundbreaking risk-based regulatory framework for AI marks a major advancement in technology governance, categorizing systems by risk levels (minimal, limited, high, unacceptable) and promoting a human-centric approach that emphasizes transparency, accountability, and ethical considerations. This regulatory position fosters a distinct "ecosystem of trust", potentially offering competitive benefits for European AI

development while protecting fundamental rights and social values.

Following our comprehensive analysis, we suggest four strategic approaches for EU nations: (1) survival strategies aimed at reducing digital divides and avoiding social polarization; (2) growth strategies that utilize AI to foster innovation and enhance quality of life; (3) defensive strategies that deploy AI to tackle sustainability issues while building strong ethical guidelines; and (4) transformative strategies focused on infrastructure development to address systemic weaknesses in digital readiness.

These findings enhance the understanding of digitalization processes within the EU and offer actionable insights for policymakers aiming to harness AI for sustainable economic growth. The research indicates that effective digital transformation goes beyond just adopting technology; it also demands coherent policy frameworks that tackle infrastructure development, workforce adaptability, regulatory innovation, and social inclusion. As EU member states navigate the intricate post-pandemic recovery phase, tailored digital strategies that consider specific regional contexts, capacities, and challenges will be crucial for optimizing the transformative capabilities of AI while ensuring its advantages are widely and equitably shared.

Future studies need to concentrate on creating more detailed metrics to assess the impacts of digitalization at both regional and sectoral levels. Additionally, we will investigate the long-term sustainability of digital transformations accelerated by the pandemic and evaluate the effectiveness of different policy measures to close digital divides and address harmful externalities resulting from swift technological advancements.

**Conflicts of Interest**

The authors have no conflicts of interest to declare.

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