

AI for Business Transformation – A Comparative Approach: The Romanian Case

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Abstract. *Artificial Intelligence (AI), despite inherent constraints, has emerged as a transformative technology, advancing capabilities in domains that depend on pattern recognition, decision-making algorithms, computational problem-solving, content creation, and human-machine collaboration. Its impact is systemic, influencing the functioning, the environment and the governance of critical infrastructures and potentially driving strategic realignments in global economic and geopolitical power structures. This paper investigates the transformative role of AI in the evolution of business practices. It offers a novel framework by introducing a generalized model that delineates AI's influence on organizational processes. The analysis leverages official documents and industry-specific reports to undertake a comparative evaluation of AI strategies across key regions, including the United States, the European Union, China, and other peripheral actors, with a focused application to the Romanian context. The results provide actionable insights into implementing AI-driven business transformations, emphasizing alignment with strategic priorities and compliance with evolving regulatory standards.*

Keywords: artificial intelligence, business transformation, business processes, competitiveness, governance models.

Introduction

In the current era of digital advancement, Artificial Intelligence (AI) stands as a cornerstone technology capable of catalyzing profound changes across multiple industries. By automating routine activities and delivering advanced analytical insights, AI is increasingly embedded within global business strategies. This integration transcends mere technological adoption, representing a fundamental paradigm shift aimed at boosting operational efficiency, driving innovation, and unlocking novel economic prospects. Simultaneously, it holds the potential to redefine global competitiveness and strategic advantages amid the intensifying dynamics of great power rivalry.

The influence of Artificial Intelligence (AI) on both business and society is extensive and multidimensional. According to a report by McKinsey & Company, AI could potentially deliver an additional global economic output of \$13 trillion by 2030, boosting global GDP by approximately 1.2% annually (Bughin et al., 2018). This transformative potential stems from AI's capacity to execute tasks traditionally associated with human intelligence, including speech recognition, decision-making, and the analysis of complex data. Such capabilities empower businesses to enhance operational efficiency, lower expenses, and create innovative products and services.

The transformative influence of AI on businesses is evident across diverse industries. In manufacturing, AI-enabled predictive maintenance systems minimize downtime and operational

expenses by precisely anticipating equipment failures. Additionally, AI-driven tools are increasingly utilized to optimize the design processes for new products, addressing complex requirements such as safety, aerodynamics, and fuel efficiency. Within the healthcare sector, AI is reshaping patient care through cutting-edge diagnostic technologies and personalized treatment strategies, delivering substantial improvements in both patient outcomes and operational effectiveness. At the same time, AI is powering research into novel medical technologies, treatments and therapies, accelerating growth in the biotech sector (PWC, 2024). Retail industries are harnessing AI to elevate customer experiences by providing tailored recommendations, optimizing supply chain operations, and streamlining customer service interactions (Deloitte India, n.d.).

The adoption and integration of AI exhibit significant regional variation, shaped by diverse economic, political, and social factors. In the Middle East, the advancement of AI is predominantly driven by strategic governmental efforts focused on diversifying economies and reducing reliance on oil resources. (PWC, 2018). The European Union steers AI development through dedicated EU funding, prioritizing the creation of "trustworthy and ethical" AI systems and establishing regulatory frameworks that safeguard data privacy and security. This approach, balancing innovation with data sovereignty, has its roots in earlier initiatives such as the General Data Protection Regulation (GDPR). In contrast, the United States leverages a dynamic venture capital ecosystem to drive rapid technological progress and AI deployment, particularly in strategically sensitive domains like defense. Meanwhile, China adopts a state-led approach to AI, characterized by substantial government funding and strategic initiatives aimed at achieving global leadership in AI technologies (Stanford University, 2024; Brookings, n.d.).

This paper seeks to investigate the role of AI in driving business transformation through a three-tiered framework. It begins with a literature review highlighting AI's capabilities and diversity, followed by the formulation of a generic model for AI-driven business transformation. The paper then explores regional variations in AI adoption before focusing on the specific potential for AI-fueled business transformation in Romania. To make these original contributions, we employed a methodology that is reliant on the study of reports from industry, policy Think Tanks, and other AI/business practitioners, while leveraging existing networks of private and public actors engaging with the AI domain. The experience of the authors in multistakeholder business networks, industry conferences, policy forums and through direct interaction with business entities provides additional insight to the one generated by the analysis of business and academic literature. Finally, we systematize the lessons on AI in business through a general framework of business processes, while trying to differentiate between different AI transformation regimes. The resulting comparative analysis is a multidisciplinary effort that includes considerations on corporate and ownership structures, fiscal issues, state capacity and state involvement in the economy.

As an EU member state, Romania faces distinct opportunities and challenges in integrating AI into its economy. While the country's digital transformation is supported by EU policies and funding, it grapples with obstacles such as labor shortages and the need for enhanced digital skills. By examining these factors, we gain a clearer understanding of how AI can be leveraged to promote economic growth and development in different regional contexts.

In conclusion, AI emerges as a transformative force with the capacity to fundamentally alter industries and economies. Through an examination of diverse regional approaches and a focused analysis of Romania's case, this paper aims to offer a thorough understanding of how AI can be strategically incorporated into business models to foster sustainable growth and

innovation. The insights derived from this study not only underscore the potential benefits of AI but also address the challenges and considerations essential for its successful implementation. Furthermore, it establishes a foundation for developing a comprehensive framework that ensures the effective, sustainable, secure, and ethical transformation of businesses through AI in the future.

The integration of AI technology into mainstream applications

In the current dynamic business landscape, AI has emerged as a key technological force, transforming industry standards, and making a significant impact across multiple dimensions, including business operations, societal structures, and ethical considerations. The adoption of AI is no longer merely an optional upgrade; it has become an essential prerequisite for businesses striving to thrive in the digital era.

AI has evolved significantly from being dismissed as a "poor choice of words in 1954" (Innovation Copilots, 2023) to being recognized as a field dedicated to creating machines capable of learning, reasoning, and acting autonomously. Today, AI is regarded as a captivating area of scientific inquiry, centered on the development of computers that replicate human-like intelligence and perform tasks traditionally dominated by humans. As AI continues to evolve, defining true intelligence becomes an increasingly intricate challenge. While experts acknowledge that current AI systems do not yet match the scope of human intelligence, the notion of strong AI—machines capable of thinking and learning like humans—remains a theoretical concept. At present, the dominant form of AI in use is weak AI, which is designed to excel at performing highly specialized tasks.

The progression of AI is characterized by notable breakthroughs in machine learning, deep learning, and other computational technologies, enabling AI to permeate a wide range of industries, including healthcare, finance, and consumer goods. This broad integration is laying the groundwork for the emergence of Artificial General Intelligence (AGI), a form of AI capable of performing any task that a human can, potentially with equal or superior efficiency (Gartner, n.d.).

Table 1. Differences between Narrow AI and AGI

Narrow AI	AGI
Weak AI systems are designed for particular tasks, such as automating repetitive activities in business environments, improving operational efficiency, yet they do not possess general cognitive capabilities.	AGI seeks to replicate human intelligence, with the potential to revolutionize businesses by allowing machines to engage in complex decision-making and problem-solving across diverse fields.
These systems function within a limited framework and excel in well-defined environments, such as customer service bots or data analysis tools, effectively streamlining business operations without possessing genuine comprehension.	AGI represents an advanced aspiration where AI could address dynamic business challenges, innovate independently, and lead significant strategic transformations.
Examples in business: virtual customer assistants, predictive analytics tools, which optimize operations and tailor customer interactions, thereby enhancing business efficiency and customer satisfaction.	Although still theoretical, the development of AGI has the potential to transform business models by offering holistic insights, adaptive learning capabilities, and operational flexibility on par with human abilities.
At present, Weak AI has a considerable impact on business by automating specific tasks, cutting costs, and enhancing efficiency, thereby enabling human workers to concentrate on more complex, strategic activities.	The potential emergence of AGI could bring about a paradigm shift in business operations, ushering in an era of intelligent automation and strategic adaptability.

The quest for AGI underscores the vast ambitions of AI research and its potential to transform our relationship with technology. As AI progresses, it becomes increasingly ingrained in production chains, in business processes but also in consumer technology, enhancing user experiences through intelligent assistants that personalize and simplify interactions. These AI-driven improvements are not only optimizing the functionality of consumer products but are also reshaping user expectations and experiences, making technology interactions more intuitive and essential to everyday life.

Several key concepts related to the implementation of AI are crucial and require a deep understanding when contemplating business transformation:

1. Understanding data dynamics – Data Management: This entails a structured approach to data collection, storage, processing, and protection, ensuring it meets the rigorous standards necessary for reliable AI applications (Hpe.com, 2024). Businesses must create robust systems for data acquisition, gathering real-time, relevant information from diverse sources. Effective data processing and storage are critical components of managing data dynamics. Organizations must adopt scalable and secure storage solutions that provide easy access to data while safeguarding it from breaches, ensuring compliance with regulations such as the General Data Protection Regulation (GDPR). The processing phase involves organizing, cleaning, and structuring data to make it suitable for analysis and ensuring that machine learning models are provided with accurate, consistent data.

Ultimately, data protection goes beyond cybersecurity measures to encompass managing access permissions, ensuring data integrity, and safeguarding confidentiality. Adhering to legal and ethical standards is crucial, as it establishes a sustainable business framework that promotes the responsible use of AI. By mastering these aspects, businesses can successfully integrate AI to foster innovation, improve operational efficiency, and secure a competitive advantage in a data-driven marketplace.

2. Training machines to learn – Machine Learning (ML): A specialized domain within AI focused on developing and applying algorithms that enable machines to learn from data. These algorithms allow machines to recognize patterns in data and use these insights to make predictions or decisions. ML is generally classified into three primary categories: supervised learning, unsupervised learning, and reinforcement learning.

3. Supervised learning involves training a model using a labeled dataset, where both input data and the corresponding expected outputs are provided. This enables the model to learn to predict outcomes based on new input data. Supervised learning is commonly applied in areas such as image recognition, speech recognition, and spam detection in emails. By leveraging supervised learning, businesses can automate tasks and enhance accuracy in areas that would typically require human judgment.

Alternatively, *unsupervised learning* involves training a model on data that lacks explicit labels, allowing the system to independently identify underlying patterns and structures. Unsupervised learning techniques are frequently used for tasks such as clustering similar data points, anomaly detection, and dimensionality reduction. This approach aids businesses in customer segmentation, fraud detection, and efficiently managing large datasets.

4. Reinforcement learning is a technique in which a model, referred to as an agent, learns decision-making by taking actions within an environment, aiming to maximize rewards and

minimize penalties. This method proves especially useful in areas like robotics, gaming, and autonomous vehicle navigation, where the machine refines its strategies through continuous real-time feedback.

Properly implementing these machine learning models necessitates ongoing training and refinement to accommodate new data and evolving conditions. By integrating ML into their operations, businesses can automate routine tasks while also gaining valuable insights into customer behavior and market trends. This continual process of learning and adaptation offers companies substantial competitive advantages, allowing them to proactively address shifts in the market and evolving customer demands, which ultimately fosters innovation and accelerates business growth.

5. Emulating human cognition – Deep Learning (DL): A specialized branch of machine learning, deep learning utilizes neural networks to replicate the structure and functions of the human brain. These networks are made up of interconnected layers of artificial neurons, which are modeled after biological neurons, enabling them to identify intricate patterns within large datasets. This ability makes DL especially valuable for business applications like image recognition, natural language processing, and speech synthesis, thereby improving automated customer support, marketing analysis, and other areas.

At the heart of neural networks are artificial neurons that process inputs from other neurons or external sources to generate outputs. These neurons are organized into layers, each serving a specific purpose: input layers collect data, hidden layers analyze it, and output layers provide the final results. Deep neural networks consist of several hidden layers, which allow them to extract progressively more abstract and intricate data representations.

Training these networks requires adjusting the weights of neuron connections to ensure precise output for specific inputs. Breakthroughs in deep learning, including convolutional neural networks (CNNs) for visual tasks, recurrent neural networks (RNNs) for sequential data, and transformers for text processing, have greatly advanced the field. These technologies enhance decision-making processes and foster efficiency and innovation across diverse business sectors, from finance to healthcare, by offering deeper insights and predictive capabilities.

6. Natural Language Processing (NLP), a branch of AI, focuses on equipping computers with the ability to understand, interpret, and generate human language. This capability enables the deployment of various business applications, such as *sentiment analysis*, which helps assess customer opinions on social media and adjust strategies accordingly; *machine translation*, facilitating communication across multiple languages for international expansion; *question-answering* systems that automate customer support by quickly responding to common queries; and *text summarization*, which enables executives to swiftly grasp the key insights from large volumes of reports and documents.

NLP technologies often rely on deep learning models, including transformers, to understand the complex relationships and structures inherent in language. These models are initially trained on extensive text datasets to recognize patterns and linguistic variations. Once this foundational knowledge is established, the models are fine-tuned for specific NLP tasks that meet business requirements, often delivering state-of-the-art results. Advances in NLP not only enhance operational efficiency but also empower businesses to automate and personalize communication, gain deeper insights into customer sentiment, and ultimately drive business transformation.

7. *Computer Vision (CV)*: a key subfield of AI that allows computers to interpret and understand the visual world. This technology is integral to numerous business applications, including image classification, object detection, facial recognition, and image synthesis. The primary goal of CV is to develop systems that can perceive and interact with their environments with the same level of proficiency as humans, thereby improving business operations and enhancing customer interactions.

The emergence of Deep Learning (DL), especially in the area of Convolutional Neural Networks (CNNs), has significantly advanced the field of Computer Vision (CV). CNNs are particularly skilled at automatically learning hierarchical representations of visual data. The initial layers of CNNs are trained to recognize basic visual components such as edges and textures, while subsequent layers identify more complex patterns, including objects and entire scenes. This ability has made CNNs the preferred choice for a wide variety of vision-related tasks, greatly improving both efficiency and accuracy in business processes, from quality control in manufacturing to enhancing security through facial recognition systems.

8. *Robotics, a combination of mechanical, electrical, and AI technologies*, enables the creation of physical machines capable of perceiving, thinking, and interacting with their environment. The development of intelligent robots, capable of performing tasks ranging from basic, repetitive actions to complex operations requiring adaptability and sophisticated decision-making, holds the potential to significantly enhance business management. By integrating AI techniques such as Computer Vision (CV) and Machine Learning (ML), robots can adjust to new conditions, learn from past experiences, and perform efficiently in dynamic environments. Key challenges in robotics include improving human-robot interactions, optimizing motion planning, and enhancing robot perception. This innovation is crucial to transforming business operations by automating processes, increasing productivity, and reducing human error across various industries.

The exploration of key AI technologies like Machine Learning (ML), Natural Language Processing (NLP), Computer Vision (CV), and robotics emphasizes their transformative influence on business operations. These technologies empower machines to learn from data, understand human communication, interpret visual environments, and perform intricate physical tasks. As organizations increasingly incorporate these AI capabilities, they open up new possibilities for enhancing decision-making, automating processes, and creating more seamless interactions between humans and machines. The ongoing integration of these advanced tools is poised to spur innovation and provide a competitive edge across diverse industries, highlighting the critical role of AI in shaping the future of business.

Nevertheless, the integration of AI into widespread applications introduces numerous ethical and societal challenges. Issues such as privacy concerns, surveillance, and the potential for large-scale job displacement demand thoughtful attention and proactive management. The societal impact of AI goes beyond individual privacy and employment concerns; it questions current regulatory systems and calls for a reassessment of what it means to coexist with increasingly autonomous technologies in our daily lives and workplaces.

Looking ahead, the progression of AI indicates a future where technologies will grow more advanced, possibly culminating in the creation of AGI. These advancements could reshape human-machine interactions, amplifying human abilities and fostering new forms of collaboration between digital technologies and human creativity. As AI technologies evolve and become more embedded in society, the necessity for robust governance structures, ethical

principles, and public participation grows stronger to ensure that AI developments serve the greater good of society.

How AI is Shaping Business Transformation

As we move further into the digital age, the growth of AI is expected to follow a similar path to the early limitations on personal computer usage, which eventually led to their widespread adoption (Makarius et al., 2020). This growth is particularly expected in sectors with high risks and regulations, including robotics, manufacturing automation (Industry 4.0 paradigms moving towards Industry 5.0), military operations, finance, and healthcare. Furthermore, the combination of occupational psychology and AI presents opportunities to enhance employee wellbeing (Felten, Raj and Seamans, 2023).

With innovations like ChatGPT, AI is bridging the gap between machine abilities and human intelligence, showcasing its vast potential and transformative effect across multiple industries. This chapter explores the key areas of AI influence that are set to revolutionize business operations in the future and offers a general framework for evaluating AI-driven business transformations.

Insights on AI Transformations from the Perspective of AI Capabilities

This sub-chapter uses the previously outlined taxonomy of AI capabilities to highlight key trends in AI's role within business.

Impact of AI on Employment

AI is poised to radically transform the job market, potentially displacing jobs in some sectors while generating new opportunities in others and augmenting current positions with advanced capabilities. According to the Future of Jobs Report 2023 (World Economic Forum, 2023), around 25% of existing jobs are predicted to undergo significant changes over the next five years, especially those focused on repetitive and straightforward tasks. AI could lead to the automation of roles like telemarketers being replaced by robocall systems, traditional bookkeeping being made obsolete by automated accounting software, and retail jobs being taken over by AI-driven bots and software. Additionally, administrative positions such as personal assistants and receptionists may be replaced by intelligent AI systems, and insurance underwriting could be handled by AI technologies. This section also draws attention to the potential misuse of AI in the absence of ethical and trustworthy guidelines, highlighting issues like user manipulation, algorithmic discrimination, inherited biases from designers, and potential violations of human rights.

Harnessing AI to Boost Workplace Efficiency and Drive Innovation

AI is increasingly being utilized across various functions in the workplace, such as human resources (HR), marketing, and production processes. HR departments, for example, are employing AI to improve the efficiency of sourcing, shortlisting, scheduling interviews, hiring, and onboarding candidates (Gartner, 2023). Different industries are finding innovative ways to incorporate AI, such as the use of AI-based computer vision (CV) systems. In manufacturing, CV can detect production line errors, while in retail, it may assist in inventory management. Insurance companies, for instance, could deploy CV-equipped drones to assess property damage claims. The augmented workforce is also taking shape, blending technologies like AI, CV, and virtual and augmented reality (VR and AR) to drive business success. Through this integration,

employees can interact with digital humans, bots, and AI assistants for routine tasks, possibly even communicating with digital entities via chat. Additionally, a significant portion of customer service duties is expected to be managed by AI-powered assistants, with human supervisors overseeing performance and intervening when necessary. However, this area also presents potential risks, as AI-driven tools could exacerbate unstable employment models that fail to provide job or income security for workers or encourage exploitative business practices, leading to employee stress and safety risks. For example, industry reports highlight how delivery personnel may take dangerous chances in traffic to meet performance targets, putting their safety at risk.

Enhancing capabilities through AI-powered applications

The incorporation of AI into both new and established applications is already improving user experiences and expanding functionalities. AI-enhanced apps are adding innovative features and extending the range of use cases for existing tools, with projections indicating a nearly sixfold growth in new AI-integrated apps by 2026 (Wiles, 2023). For example, Grammarly, an online writing tool, has incorporated AI-driven features that analyze users' unique writing styles and patterns in real time, offering personalized suggestions that significantly enhance its functionality (<https://www.grammarly.com/ai>). Similarly, Replika, an AI-powered chatbot, helps businesses engage with customers by utilizing large language models (LLMs) and natural language processing (NLP) to understand user requests and respond in a conversational tone. Another innovative application of AI can be found in FaceApp, which uses AI to modify facial expressions and features in photos, adding effects such as different hairstyles, makeup, or aging transformations. The app's AI algorithms analyze facial details and apply changes with remarkable realism, demonstrating AI's advanced capabilities in image processing and editing. These examples illustrate the growing and dynamic role of AI in enhancing app functionalities, a trend that is expected to expand across various applications. As AI continues to be integrated into more tools, many of these applications will likely come under scrutiny from countries adopting the EU framework on AI product risks, which addresses concerns such as manipulation, discrimination, unlawful tracking, and potential violations of human rights.

AI-Driven Personalization

In today's business environment, customer interaction plays a crucial role, and personalized experiences are now achievable on an unparalleled scale. An increasing number of companies are harnessing AI to provide customized product, service, and content recommendations, boosting both revenue and customer loyalty. This technology has become more accessible, enabling businesses of all sizes to enhance their customer interactions. For years, leading streaming platforms such as Netflix and Spotify have utilized AI to deliver personalized content by analyzing users' viewing or listening histories and suggesting movies, shows, or music that match their individual preferences. (Litslink, 2024). E-commerce giants such as Amazon employ similar AI-driven strategies, leveraging data from past customer purchases and browsing behavior to provide personalized product recommendations. Startups and smaller businesses have also begun incorporating AI technology, as it becomes more accessible and affordable. Independent merchants and tech firms can now utilize these AI features to enhance consumer engagement and boost conversion rates. The widespread adoption of AI personalization technologies promises to democratize advanced marketing tactics across the industry, fostering more dynamic, customer-centric work cultures.

Enhancing Creativity through Generative AI

Business operations are undergoing continuous transformation thanks to the capabilities of generative AI, which facilitates the creation of new text, images, and videos, thereby saving both time and costs. Tools such as ChatGPT and Jasper are becoming indispensable in helping users generate a wide range of content, from blog posts and video scripts to song lyrics and poetry. A key benefit of these technologies is that they empower users to explore and create various forms of media. Additionally, AI-powered image generators like OpenAI's DALL-E allow individuals without formal design expertise to create high-quality visual content simply by providing text descriptions.

This trend is disrupting professional fields, as generative AI is now making an impact on creative industries such as photography and graphic design. AI-generated images can replicate or even enhance human-created visuals, offering new opportunities for both amateurs and professionals to showcase their work on social media platforms.

The adoption of generative AI is poised to increase, driven by improvements in the quality and variety of content it can produce. As businesses leverage this technology, they will broaden their creative capacities across different formats and media, profoundly altering how they create and share content. This evolution is expected to reshape industry norms for digital creativity, providing businesses with unparalleled opportunities to innovate in areas such as marketing, product development, and customer engagement, thus catalyzing a significant shift in business transformation strategies.

This is already sparking concerns about the improper use of intellectual property in training datasets and the potential distortion of AI outcomes when AI-generated content is included in those datasets.

Progress in Multimodal AI Technologies

Businesses are increasingly adopting multimodal AI models to efficiently process and generate results across various media types (text, images, audio, and video). These models are designed to handle data from multiple sources simultaneously. For instance, a multimodal AI model could analyze both text and image inputs, enhancing applications such as an AI robot that can read and summarize a newspaper while also answering follow-up questions, all in real-time. A notable advancement in this field is LLaVA (llava-vl.github.io, n.d.), an open-source large multimodal model developed through a collaboration between the University of Wisconsin-Madison, Microsoft Research, and Columbia University. LLaVA-Med (Li et al., 2023), a specialized version of this model, is designed for the healthcare sector, responding to inquiries related to biomedical images. Another notable development is ImageBind (<https://imagebind.metademolab.com/>), which aims to replicate human vision across multiple data types, including text, images, videos, and even 3D measurements. Additionally, Meta's SeamlessM4T algorithm (Meta, 2023) stands out for its proficiency in a range of translation and transcription tasks, facilitating seamless communication between speech and text.

Improving Software Development through AI

Software engineering is experiencing a transformation with the integration of AI, which enhances developer creativity, improves code quality, and accelerates the development process. AI applications in this field span from generating unit tests to verify new code and detect bugs, to assisting in code writing, such as GitHub Copilot's (GitHub, 2023) ability to create unit tests for form inputs. AI can also manage large software systems and translate code between different

programming languages, especially when combined with a model-driven development approach. This methodology uses a predefined "blueprint" of the code's functionality, which AI can leverage to generate or assess code that meets specified requirements. AI tools also support developers by organizing datasets for more efficient testing and reducing data management costs.

The Emergence of Quantum AI

AI and quantum computing are collaborating to address computational challenges that exceed the capabilities of traditional machines. The integration of AI algorithms with quantum computing hardware enhances performance in areas such as big data processing, complex decision-making, and speech recognition. Quantum AI is already making an impact across various industries, including high-resolution weather simulation, financial risk assessment, and drug development. The synergy between AI and quantum computing is expected to unlock even more groundbreaking practical applications by 2025 and beyond, further expanding the potential of computing technologies.

The widespread influence of AI has significantly transformed business operations and the employment landscape across various sectors. By reshaping job roles and generating new opportunities, AI is redefining the future of work, enhancing workplace efficiency, and fostering innovation. Multimodal AI technologies are revolutionizing the industry by seamlessly integrating and analyzing diverse data types, enabling the handling of tasks across text, images, audio, and video. As AI-augmented applications continue to expand their capabilities, they deliver personalized experiences at scale and enhance customer engagement through tailored product recommendations.

Furthermore, generative AI is transforming creativity by enabling businesses to generate new content—ranging from text and images to videos—more efficiently and at a reduced cost. This technology empowers users to create sophisticated media, enhancing strategies in marketing, manufacturing, and customer engagement. Advancements in AI-powered software engineering are also boosting developer productivity, improving code quality, and optimizing programming workflows. Meanwhile, quantum AI is unlocking new possibilities in advanced decision-making and big data analysis, surpassing the limits of traditional computing.

The integration of these AI advancements is not only transforming industries but also establishing new benchmarks for future business practices. Adopting these technologies will be essential for companies seeking to stay competitive, innovative, and adaptable in the fast-changing digital environment. By harnessing the full range of AI capabilities, businesses can drive substantial transformation, ensuring they maintain a leading position in their respective sectors.

Indeed, quantum technologies have raised concerns about the potential vulnerabilities in data encryption for both businesses and governments, leading many stakeholders to develop quantum transition strategies aimed at ensuring quantum-safe security. AI further amplifies these risks, as it increases the likelihood that businesses may struggle to safeguard their data. Hackers are already exploiting current encryption methods by stealing data now, with the intention of decrypting it once quantum computing technologies become advanced enough to break existing encryption systems.

Towards a New Framework for Business Theory Driven by AI-Led Transformation

In his seminal work on the nature of the firm, Ronald Coase explored how businesses are structured and how they adapt to challenges such as technological limitations, societal norms,

regulations, transaction friction, market disruptions, and regulatory risks (Coase, 1937). However, this framework was based on a technological paradigm that has been rapidly reshaped by digitalization, continuous connectivity, automation, and globalization. With the advancement of AI, there is a growing need for a new "theory of the firm" that incorporates AI to better understand the transformation of businesses.

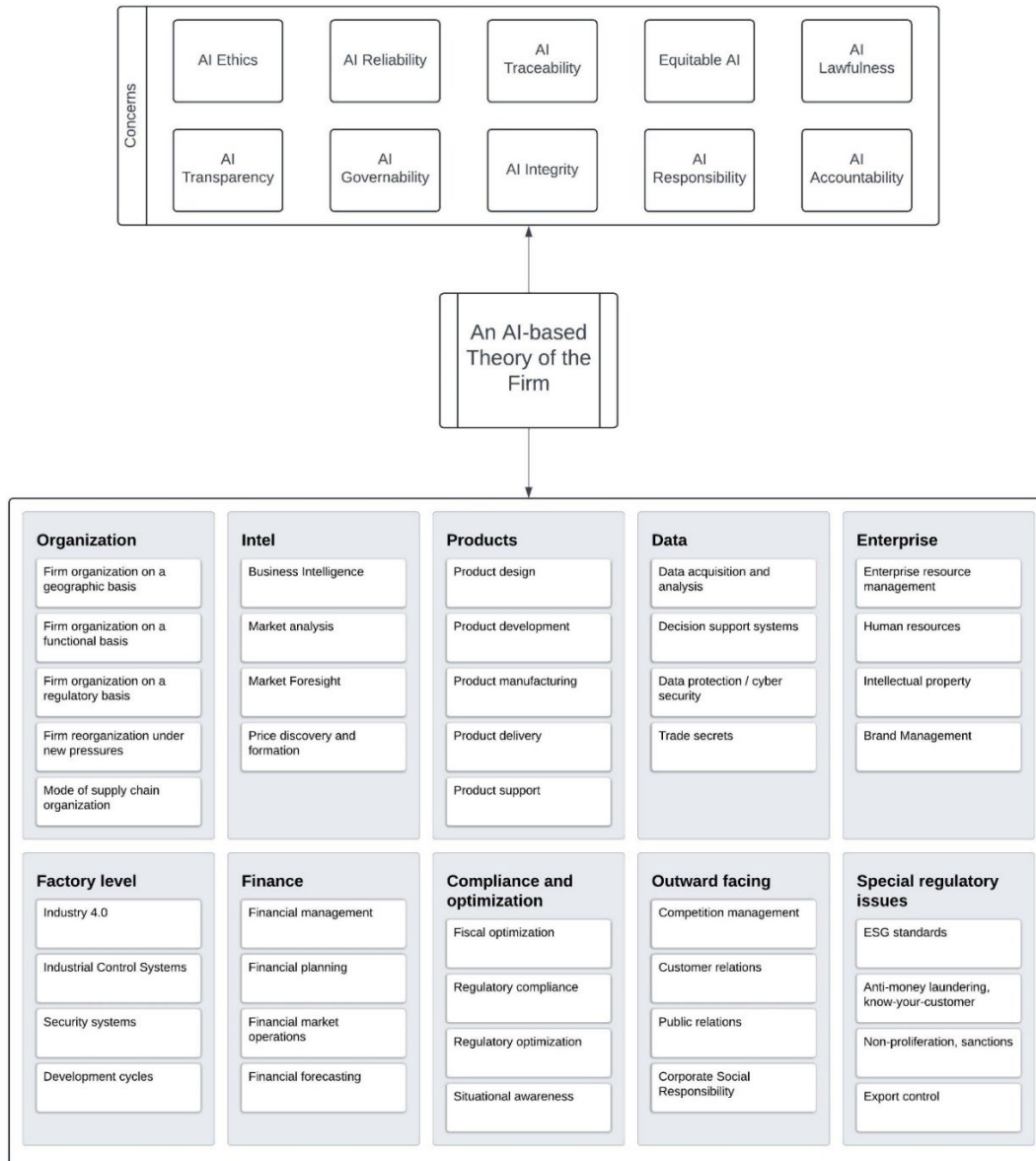


Figure 1. An initial model for an AI-driven theory of the firm

Source: Author's own research.

Figure 1 summarizes the literature review conducted in this research to organize the impact of AI on key business functions and to highlight the concerns surrounding AI implementation. These concerns are primarily derived from major US and EU reference documents on "ethical and trustworthy AI," such as The Department of Defense AI Principles, the NATO AI Principles, the OECD AI Principles, and the EU Report from the High-Level

Commission on AI. Essential attributes of "ethical and trustworthy AI" include reliability, transparency, governability, traceability, integrity, and lawfulness. Notably, Western voluntary codes and other frameworks are beginning to converge through transatlantic cooperation (Georgescu, 2022a).

For example, an analyst using such a reference model might argue that AI implementation will accelerate the speed of new product releases and enhance the ability to adapt to shifting market dynamics and demands. The availability of critical resources is also transformed under AI's influence. In Coase's model, the firm offers stable employment but faces the risk of labor under-utilization, particularly in retail environments where certain periods of the day or week experience significantly lower commercial activity. This happens due to the friction involved in scaling labor up or down to improve efficiency. In simpler terms, most businesses cannot hire and fire employees daily based on market conditions, as it cannot ensure the availability of labor when needed. AI tools, however, can offer data analysis, decision-making, and resource management capabilities that can resolve many of these challenges. The replacement of human workers with AI running on outsourced platforms and infrastructures gives businesses on-demand access to AI services exactly when and to the exact extent they are needed, perfectly matching expenditure and business output. Paradigms such as Platforms-as-a-Service or Infrastructure-as-a-Service are moving from the area of cloud computing into that of AI implementation, giving businesses unparalleled flexibility. Given the increasing concerns around "precarious labor" models, especially in the "gig economy" and other sectors, it is possible that AI could become so effective that political and labor leaders may seek to regulate its use to mitigate its social impacts.

A Comparative Analysis of AI-Driven Business Transformation

Georgescu (2022a), Caba-Maria et al. (2024), and others have highlighted that the application of AI across different sectors is influenced by a range of factors, including economic structure, whether the innovation is locally developed, geopolitics, and more. As a result, the experience of AI-driven business transformation varies not only between companies or industries but also across different governance systems. Distinct transformation models emerge naturally, shaped by the governance framework in each region, which encompasses regulations, financing opportunities, and environmental factors such as competitive pressures, business culture, and the level of expertise in the economy. This sub-chapter presents an initial attempt to define various types of AI-driven business transformation, identifying key characteristics that apply to a wide range of countries through influences and geopolitical competition. We have identified four main approaches: the US approach, the EU approach, the Chinese approach, and a fourth approach representing actors with unique development paths based on local conditions, which can be influenced by others but generally do not exert significant influence on others. The US, EU, and China collectively account for a substantial portion of the global economy, innovation, AI funding, and major companies. As such, their respective models will significantly shape AI-driven business transformation globally, both through proportionality and the influence they exert on other regions. The final category encompasses diverse models, such as those identified by Caba-Maria et al. (2024) for the Middle East, but these are united by their limited systemic relevance and lack of influence on other regions.

In developing this framework, we focused on five key categories and posed critical questions within each: innovation, geopolitical competitiveness, financial matters, regulation, and the degree of free market operation. The findings are summarized as follows:

The US stands out as one of the most innovative and dynamic AI actors globally. Companies are eager to implement AI-driven transformations due to competitive pressures. Ample resources are available to fund innovation and drive transformation, with a continuous effort to diversify AI applications, which also enhances the potential complexity of AI-driven changes. The Biden Administration has accelerated the development of regulations and regulatory frameworks (Georgescu, 2022a), while also fostering significant AI partnerships with the EU and other like-minded nations. However, the new Trump Administration is rolling back regulation in the idea that it is discouraging innovation and to try to maximize the US edge over in China (and the EU) in building scalable market products with advanced technology.

The EU is a less dynamic player in the AI field compared to the US and China. It allocates less funding to AI initiatives and has a more heterogeneous internal market. The number of large companies, particularly in the tech sector, is smaller, and there are fewer startups, which limits the speed and extent of AI-driven transformation. Its potential market is, however, extensive, which makes it an asset to European companies and a target for US and Chinese companies which sometimes view EU legislation as deliberately targeting them to protect their local champions. While the EU is developing comprehensive regulations that could slow down AI innovation and business transformations, it is addressing crucial concerns related to individual rights and European values. The EU views regulatory cooperation as a key strength and is keen to export its framework through the "Brussels Effect," which has already been successful in other regulatory areas. To stimulate innovation and foster research, the EU relies on centralized funding mechanisms. However, scalability remains a challenge for AI technologies and tools developed within the EU.

China is a highly dynamic player in the AI space, with the state playing a central role in advancing research and driving the AI-driven transformation of its companies. Initiatives such as the Digital Silk Road allow Chinese firms to identify international clients for AI services while securing state-supported funding for infrastructure and expansion. The government maintains substantial control over key companies, particularly in deciding whether private entrepreneurship is permitted in critical sectors. China is particularly strong in scalability, able to mobilize significant resources once a strategic need is identified and key stakeholders for implementation are in place.

Non-systemic countries exhibit a patchwork approach to AI adoption within businesses. Typically, subsidiaries of foreign companies are the first to implement AI-driven transformation, leveraging financial resources, expertise, and technology from abroad. Governments in these countries tend to select specific strategic areas to focus on, such as healthcare, social services, and maintaining social harmony, often linked to digital authoritarianism. Due to global market concentration in the tech sector, these countries become dependent on foreign suppliers, who, in turn, gain leverage to promote preferred models of AI regulation and foster cooperation on AI-related matters.

Table 2 presents the main findings of the comparable analysis.

Table 2. Comparative analysis of four main AI-driven business transformation models

	US	EU	China	Non-systemic third countries
Innovation	High levels of innovation in a complex ecosystem	High levels of innovation in a heterogeneous and fragmented ecosystem	High levels of innovation in a relatively simple ecosystem	Low levels of innovation, except for case by case practical applications
Market principles	Free and competitive market	Regulated markets	Regulated markets, with high state involvement	Underdeveloped markets
Regulation	Regulation generally minimal to not affect innovation	High levels of regulation	Some regulation, but effect achieved mostly through synchronization between main players and government	Low levels of regulation but also low state capacity. More likely to adopt regulatory frameworks of others.
Entrepreneurship	High levels	Relatively lower levels, risk aversion	High levels, with political subordination beyond a certain level or for key technologies	Low levels of tech entrepreneurship
Size of market for AI business transformation	Large, companies are competitively motivated to implement technology	Large market, but less pressure to adopt new technologies	Large market, state-incentivized business transformation through high levels of coordination	Small markets generally unable to sustain high levels of local innovation
Characteristics of the companies	Large companies, well capitalized, easy access to venture capital	Lower number of large companies, lower rates of capitalization, lower levels of venture capital	Large companies, strong state support for capitalization	Smaller companies, with exception of state champions, difficult access to capital
Access to know-how and specialty tools	Significant access	Significant access, with regional variation	Significant access through state developed toolkits	Low access
Pressure to transform	Significant competitive pressure	Lower pressure, incentives through central funding programs	State-led reorganization of the economy	Low pressures due to low competition and resources
Start-up formation rate	High levels of start-up formation	Lower levels of start-up formation	Selective permission for private sector in sensitive fields	Low rates of start-up formation
Level of funding for AI transformation and innovation	Possibly the highest in the world, strategic imperative	Lower levels of funding, much of it state-oriented	Possibly the highest in the world, much of it state-oriented	Low levels of funding
Safeguards on AI use	Increasing level of regulation	Restrictive approaches	Increasing level of regulation; direct coordination	Low levels of regulation due to perceived lack of need
Priority AI applications	Full spectrum, emphasis on security and industrial control systems	Full spectrum, emphasis on energy systems and innovation	Full spectrum, priority on civil-military dual-use applications	Priorities differ, with emphasis usually on health, labor, education, law and order

	US	EU	China	Non-systemic third countries
Infrastructure	Significant investment into data centers	Fragmented effort into increasing infrastructure	Significant investment into data center	Uses services and infrastructure of others
Driver for security	Companies fear liability and market effects, state regulation secondary	Led by Commission and authorities through efforts such as NIS 2 and Cyber Resilience Act	State-led through regulation and direct coordination of security transformation for critical entities	A mix of regulation and implementation of best practices by local subsidiaries of foreign entities
Driver for AI exports	Dominant companies leveraging scale and market position	Regulation and multilateral cooperation	National champions, mostly state-owned, driven by strategic initiatives like Belt and Road Initiative	Generally unable to export AI services; promising companies are taken over by global champions
AI Securitization	Significant capabilities and initiatives such as AI Partnership for Defense	Reluctance to develop, defensive posture only	Civil-military fusion, security concerns are primary and override economic concerns	Cognizant of risks, requires assistance for implementation, lack of resources and know-how to keep security in line with growth
AI partnerships	PPP key, cooperation with like-minded partners based on fundamental values (especially EU)	PPP key, cooperation with like-minded partners based on fundamental values (especially US)	Civil-military fusion enables direct state control, pragmatic partnerships with wide range of countries and geopolitical projects	Pragmatic approach based on economic interests; cognizant of role of its cooperation in the emerging Great Power rivalry
Access to skills	Magnet for expertise from all over the world; leading universities in research and education on AI/cyber	Requires many more experts, tries to compensate through internal resources	Large population and emphasis on technical education guarantees significant resources; academic excellence	Low but growing levels of internal skilled cadres; overall penury; attempts to make up deficit through outsourcing; significant gaps

Source: Author's own research.

The three main models not only highlight the key actors but also the primary countries associated with them, forming part of cross-border ecosystems and regulatory frameworks.

The Case of Romania in AI-Driven Business Transformation

Romania serves as a unique example of a non-systemic player approach to AI-driven business transformation, despite its membership in the EU. Its involvement in both the EU and NATO provides a broad and evolving framework for AI governance that Romania is obligated to adhere to. Additionally, Romania has the opportunity to leverage its membership to define national priorities and advocate for them alongside like-minded partners within these organizations. As a result, these frameworks can be better aligned with the needs of advanced but non-systemic players.

Romania's approach will, inevitably, be influenced by European standards, particularly in aligning with other key players, especially regarding AI regulation. The country stands at a pivotal moment where the adoption of AI could greatly accelerate its economic growth and development. As an EU member state, Romania enjoys access to EU funding and regulatory frameworks designed to promote technological progress and innovation in a secure and sustainable manner. According to the European Commission, Romania can tap into substantial funds through programs such as Horizon Europe, which is focused on driving innovation and research across the EU. Moreover, the EU's Digital Europe Programme is poised to make significant investments in AI, cybersecurity, and advanced digital skills, providing direct benefits to member states like Romania (European Commission, 2021).

Our research involving industry literature, open media sources and specific knowledge gained from networks at the intersection of business and technology suggests that there are two types of AI adoption in Romania: formal adoption by entities pursuing new strategies or upgrading their products and services, and informal adoption by individual workers or teams to enhance their own efficiency with limited support or oversight by higher level management.

In the first category, we have numerous examples starting from business support functions, where AI adoption is quickest with the most mature products and the lower amount of risk. For instance, FAN Courier, a delivery company, implemented AI assistant technology from DruidAI to enable clients to have seamless business interactions including self-tracking and to manage complex order chains not just by individuals but also other businesses using FAN Courier (DruidAI, 2023a).

The Regina Maria private healthcare network in Romania went further and adopted an AI chatbot for supporting managers, healthcare professionals, customers and patients online. The tool is much more developed, since ANA is “an intelligent AI agent that integrates with the client’s five operating systems and links seamlessly to the existing multi-vendor application ecosystem. It is trained to take on tasks, communicate decisions and operate in internal systems while also connecting three of Regina Maria’s most important departments: medical, sales, and customer service. Managers can now access ANA 24/7 on any device (desktop, laptop, or mobile) through Microsoft Teams, thanks to a secure, hybrid deployment with an on-premise RPA connector.” (DruidAI, 2023b) Note the emphasis on cybersecurity, given the high level of interlinks between key functions of the enterprise. Proving that success breeds and appetite for further development, Regina Maria then started using AI tools for analysis of medical imaging products, specifically X-rays and CTs (Computer tomography) of chests for which XVision, the vendor of the algorithm, had secured a significant database of medical data with millions of X-rays that enabled the training of a high performing algorithm (Regina Maria, 2023). This speeds up diagnosis and reduces error rates. Adoption was helped by specialized training for Regina Maria staff from the vendor. Regina Maria decided to take this step of inserting AI products into the medical investigation itself having worked with the same vendor on a pilot in Timișoara in 2021 on the validation of the accuracy of post-covid monitoring of patients.

In the banking sector, Banca Transilvania was the first financial institution to leverage AI capabilities through Robotic Process Automation (RPA) for banking operations, as well as Large Language Model (LLM) integration with chatbots on its main website and its financial education website (FIT – finance for everybody), delivered through Microsoft Azure OpenAI. Its latest integration of AI, in January 2025, is the chatbot of the Banca Transilvania application, developed with DruidAI, which allows for much more complex interactions and analyses,

including counselling on bank products which can then be transferred over to a sales officer (Banca Transilvania, 2025).

One last example is that of foreign retail giant Auchan, which introduced the Felix personal assistance to its Romanian operations, interacting with numerous stakeholder categories and offering technical support, business counselling and e-commerce support. Most of the instance of its use in the first six months since launch were for the e-commerce segment of the retail business, with a 98% success rate of the chatbot (Auchan, 2023).

Lastly, while few companies would likely admit it for fear of seeming to devalue their product, there are ample reports of the use of AI for coding and debugging within the Romanian IT industry, as well as for secretarial work.

Challenges to Romania's AI-led business transformation

However, to fully leverage AI, Romania must overcome several challenges, such as labor shortages and the need for improved digital skills. The World Bank points out that Romania is experiencing a shrinking workforce due to demographic changes, including an aging population and high emigration rates among younger, skilled workers (World Bank, 2023). This demographic shift intensifies the need for AI to address labor market gaps by automating routine tasks and boosting overall productivity.

Furthermore, the digital skills gap in Romania poses a major obstacle to the successful adoption of AI technologies. As highlighted by the European Commission's Digital Economy and Society Index (DESI) 2023, Romania ranks among the lowest in the EU regarding digital skills and internet usage. This gap emphasizes the urgent need for comprehensive education and training programs to empower the workforce with the essential skills required to effectively utilize AI technologies (European Commission, 2023).

Investing in digital education and vocational training is essential. Initiatives such as the Romanian government's "Digital Innovation Centers" are designed to improve digital literacy and offer specialized training in AI and related technologies (World Bank, 2023; Autoritatea pentru Digitalizarea României, n.d.). Additionally, partnerships with universities and private sector stakeholders can help develop curricula that are in line with the rapidly changing demands of the AI landscape.

Another challenge lies in the regulatory environment. While the EU offers a strong framework for AI development, Romania must ensure that its local regulations align with EU standards while also creating an environment that fosters innovation. The General Data Protection Regulation (GDPR) serves as a foundational framework for data protection; however, the implementation of AI technologies also necessitates the development of regulations that address ethical considerations and ensure transparency and accountability in AI applications (GDPR.EU, 2019).

Many analysts have discussed the impact of brain drain on economies. However, there is another form of "drain" in which locally generated innovation does not lead to the creation of national champions that develop their own ecosystems. This issue arises from factors such as an inefficient pipeline between fundamental research, applied research, and product development, within an ecosystem involving academia, government, the military, and the private sector. The lack of supportive financial, regulatory, and cultural frameworks to encourage innovative start-ups, and the absence of mechanisms for matching them with investors, hinders their ability to grow, achieve critical mass, and benefit from economies of scale. As a result, countries like Romania risk becoming what we might call "incubator economies," where promising start-ups

are acquired and integrated into foreign ecosystems with more developed capital markets, which offer the most direct route to success for local entrepreneurs. This situation leads to countries like Romania being unable to capture a larger share of the value generated by local innovation, relegating them to peripheral roles in the innovation-driven economy of the future. This represents an “innovation drain,” where the benefits flow to more established nexus economies, leaving newer actors with limited opportunities for growth. The prevailing global perspectives on innovation, promoted by leaders in these nexus economies, often overlook these dynamics, which can result in national vulnerabilities. Such neglect may lead to underinvestment in domestic research, reliance on external funding, and the rise of reactionary political movements against globalization.

This issue is further exacerbated by structural problems within the Romanian economy, as highlighted by Georgescu (2022b) in his influential work, *Capitalism and Capitalists Without Capital in Romania*. He characterizes the Romanian economy as being divided between local subsidiaries of foreign corporations, inefficient state-owned enterprises, and a vast majority of Romanian firms that are undercapitalized, too small, lack economies of scale, and suffer from poor management due to cultural factors and skill gaps. The connection to our discussion of AI-driven business transformation is clear—while foreign champions have the incentives and frameworks for transformation driven by top-down global decisions, Romanian firms lack the resources, vision, and scale to leverage AI tools, thus missing out on the competitive advantages AI implementation offers. Similar concerns have been raised in research on Eastern European economies, such as that conducted by the Kosciuszko Institute on cybersecurity investment and potential in the context of the Three Seas Initiative (Albrycht et al., 2019). Overcoming these systemic challenges will require long-term, multistakeholder efforts.

Tackling these challenges will necessitate coordinated efforts among government, industry, and academia. Public-private partnerships can play a crucial role in advancing AI adoption and innovation. For example, the collaboration between the Romanian government and tech companies during the COVID-19 pandemic showcased the potential of AI in public health initiatives. Expanding such partnerships to other sectors could promote AI-driven solutions that enhance economic resilience and foster growth. Targeted efforts in key industries, as well as critical infrastructure sectors like energy, transportation, and security, can help catalyze AI-driven business transformations while aligning with national strategic priorities.

In conclusion, Romania stands at a critical juncture to leverage AI for significant economic development. However, unlocking this potential requires addressing challenges such as labor and skills shortages, aligning regulatory frameworks with EU standards, and fostering a culture of innovation through collaborative efforts. By taking these steps, Romania can harness the transformative power of AI to enhance its economic competitiveness and improve the quality of life for its citizens.

Policy recommendations for Romania

Romania can receive great benefits from a sustainable and successful adoption of AI technology as well as national involvement in this growing industry. This section will present some recommendations for policymakers to heighten the positive impact of AI on Romanian business.

The first proposal is for the government, at all of its levels (local, national, sectoral), to act as a market maker by becoming a consumer of AI-related products, sourced from Romanian companies and, where this is not possible, developed with targeted money within the research, development and innovation ecosystem of the country through a competitive call for projects. In

this way, Romanian entities may scale their services and support mechanisms and mature enough to then try to internationalize.

The second proposal is for a formal university-public authority system of encouraging start-ups that is less reliant on programs such as Start-Up Nation. Rather, universities would allow students and researchers to open companies based on work done in public laboratories and with public infrastructures, provide various kinds of support, from accounting to intellectual property rights and trademark registration, and provide business support that founders may be lacking. In exchange, the hub operator receives a percentage of the new company. This is a model that already functions abroad both within incubators and for universities, but Romania must adapt the model to its local conditions.

Thirdly, Romania must implement European legislation but must also calibrate its national legislation in order to find the right balance between security, human rights, innovation and efficiency, in order to avoid discouraging start-up formation or investment into AI in existing companies.

Fourthly, the Romanian authorities can launch a “National Automation Initiative” providing funding, subsidized consulting, and loans for strategic categories of businesses (like SMEs, businesses from depopulated areas, or businesses in key sectors) to automate processes, including through the use of AI, since DESI 2023 points out that Romania is in last place in the EU with regards to automation, despite the country’s demographic issues.

Lastly, the Romanian authorities could create a National AI Partnership that brings together the competent authorities, AI product companies and various stakeholders for regular meetings to debate policy proposals and how scarce resources could be used to promote safe and sustainable AI adoption for productivity growth. There can also be sectoral working groups, such as for finance, retail, education, and healthcare, to identify opportunities and challenges that are specific to each area. This is an existing model for many other industries, both in Romania and abroad/

Conclusion

The term AI refers to a broad range of technologies and methods with diverse applications that are expected to usher in a new era of automation across sectors such as robotics, data analysis, decision-making, content creation, and more. While extensive research has been conducted on the strategic and geopolitical implications of AI adoption across various fields, and its potential to enhance specific economic sectors in terms of innovation and efficiency, less attention has been given to the impact of AI-driven business transformation. Additionally, the emerging models and perspectives regarding AI governance and regulation remain underexplored. This paper aims to address this gap by organizing the current discourse on AI's potential in business and developing a generic model for AI-driven business transformation that can be applied across a variety of contexts. An original contribution of this study is the preliminary analysis of four emerging types of AI-driven business transformation, grounded in governance paradigms and country profiles. These models—representing the US, EU, China, and non-systemic countries—are defined, with their key features and challenges outlined. Lastly, a case study of Romania is presented, exploring the opportunities and challenges associated with Romania's position within the EU governance framework, alongside specific internal factors shaping the Romanian business environment.

Future research will aim to build upon the systemic contributions presented in this paper, applying these frameworks to more specific analyses of AI-driven business transformations

across different countries and sectors. By providing sufficient detail and systematization, the research will enable both quantitative and qualitative analyses, incorporating digital tools for automated multifactorial assessments based on key datasets. Ultimately, this could lead to the development of an index for business transformation through AI. These and other research outputs will be valuable for practitioners, helping them to analyze, plan, implement, and evaluate AI-driven business transformation programs to enhance efficiency, competitiveness, and foster the creation of new capabilities. As for key topics of this future research, it will be very important to estimate the social and cultural impact of AI adoption, the impact on cybersecurity for companies, the requirements of education for employees, as well as macro-level research into the impact of AI on categories of workers and consumers. On particularly fruitful area of research will be the intersection between AI and other digital emerging technologies such as digital twins, or blockchain, where there can be unanticipated efficiencies and growth as well as new challenges for regulators and industry to address.

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