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The Economic Pathway of Intelligent Digital Transformation in Light of the Forecasts of the Fifth Industrial Revolution

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ABSTRACT

This study examined the economic trajectory of smart digital transformation in the context of the Fifth Industrial Revolution, focusing on its economic and social implications and emerging business models. It also sought to assess successful international experiences and extract key lessons. Methodology: A descriptive-analytical approach was adopted, involving a review of literature on industrial revolutions and digital transformation, analysis of economic and digital indicators from international reports, and examination of applied models in pioneering countries. Results: The findings revealed that the Fifth Industrial Revolution promotes integration between humans and machines, emphasizing sustainability and the bioeconomy. Digital transformation was found to have a positive impact on productivity and economic growth, though challenges remain, including labor market restructuring and widening inequality. The study also identified the rise of new digital business models, such as the sharing economy and subscription economy, and showcased how some countries achieved successful digital transformation through comprehensive strategies. Conclusion: The study concluded with several recommendations: strengthening digital infrastructure, reforming education systems, and updating legislative frameworks. It further stressed the importance of private sector adaptation to these transformations through innovative business models.

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Introduction

The world has witnessed profound transformations in recent decades with the advancement of digital technology, transitioning from the Fourth Industrial Revolution— characterized by automation and artificial intelligence—to the early features of the Fifth Industrial Revolution, which seeks to achieve human–machine integration and enhance sustainability. Intelligent digital transformation is one of the key drivers of this new phase, reshaping economic structures and creating innovative business models that rely on data and advanced technologies such as artificial intelligence, the Internet of Things, and cloud computing. In this context, studying the economic pathway of intelligent digital transformation becomes particularly important, especially given the challenges and opportunities posed by the Fifth Industrial Revolution—such as changes in work patterns, the rise of the bioeconomy, and the need to balance productive efficiency with social and environmental dimensions.

Significance of the Study

The importance of this study lies in:

- Identifying the economic transformations associated with the Fifth Industrial Revolution in comparison with the Fourth.
- Analyzing the impact of intelligent digital transformation on economic growth, productivity, labor markets, and social justice.
- Studying emerging digital business models such as the sharing economy and smart platforms.
- Drawing lessons from international experiences (Jordan, Saudi Arabia, the United Arab Emirates, Singapore, China) in adopting digital transformation.

Research Problem

The central research problem revolves around the following main question: How does intelligent digital transformation shape a new economic pathway in light of the forecasts of the Fifth Industrial Revolution?

From this question emerge several sub-questions:

- What is meant by the Fifth Industrial Revolution?
- What are its key enabling technologies?
- How is intelligent digital transformation defined?
- What are the economic impacts of intelligent digital transformation?
- What are the most prominent digital business models that have emerged in the context of the Fifth Industrial Revolution?
- How do smart technologies (such as Artificial Intelligence, the Internet of Things, and Blockchain) affect key economic sectors (industry, services, and finance)?

What challenges do businesses face in adopting digital business models?

Study Objectives This study aims to:

- Analyze the features of the Fifth Industrial Revolution and its impact on the global economy.
- Assess the effects of intelligent digital transformation on various economic sectors.
- Examine the emergence and evolution of digital business models within the context of the Fifth Industrial Revolution.
- Compare successful international experiences in digital transformation and extract lessons learned.
- Provide recommendations to maximize the benefits of digital transformation in achieving sustainable development.

Study Methodology

The study adopted a descriptive-analytical approach through a review of literature related to industrial revolutions and digital transformation, analysis of economic and digital indicators from international reports, and the examination of applied case studies from countries such as Jordan, the United Arab Emirates, Saudi Arabia, Singapore, and China.

The Fifth Industrial Revolution — The Fifth Economic Revolution

Over recent decades, humanity has progressed through successive development phases, leading to the Fourth Industrial Revolution (4IR), also called Smart Manufacturing. This revolution represents the digital transformation of manufacturing, driven by automation, connectivity, and real-time optimization, and relies on technologies such as IoT, AI, robotics, blockchain, big data, cloud computing, 3D printing, VR, machine learning, and 5G (Ahmed, 2023, p. 2).

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Digitization has interconnected physical assets and production systems, enabling real-time monitoring, predictive maintenance, and optimized decision-making. These innovations reduce production and logistics costs while opening new revenue streams through digital products, customized production, and agile supply chains (Ahmed, 2023, p. 4; Schwab, 2016, p. 15). Deloitte reports that predictive maintenance can cut planning time by 20%–50%, increase equipment availability by 10%–20%, and lower maintenance costs by 5%–10% (Coleman, 2017).

However, the 4IR also poses challenges, including job concentration in large corporations, prioritization of high-skilled work increasing inequality, and risks of cybercrime and technology misuse, raising ethical, security, and economic concerns (Ahmed, 2023, p. 4)

Visions of the Fifth Industrial Revolution

The contours of the Fifth Industrial Revolution have begun to take shape in the minds of industry leaders and scientists, whose perspectives generally fall into two main directions. The first vision centers on human–robot collaboration, while the second moves toward the bio-economy. These are outlined as follows (Ahmed, 2023, pp. 5–8):

First Vision: Collaborative Robots

The Fifth Industrial Revolution (5IR) emphasizes human–machine collaboration, where humans handle creative and complex tasks while robots perform repetitive or hazardous work, promoting sustainability. Unlike the Fourth Industrial Revolution, which focused on digital interconnection and data optimization, the Fifth integrates human creativity with mechanical precision through collaborative robots (cobots), advanced networks (6G), AR, MR, XR, cognitive, edge, and fog computing.

These technologies enhance operational efficiency, decision-making, and continuous learning across sectors such as manufacturing, healthcare, finance, and autonomous systems. Despite their potential, over two-thirds of industries have yet to fully adopt 4IR technologies due to COVID-19, creating opportunities to either leap to 5IR applications or gradually implement core technologies.

Second Vision: The Bioeconomy

The second vision of the Fifth Industrial Revolution centers on the bioeconomy, which is based on the utilization of renewable biological resources and their transformation, along with waste materials, into value-added products such as food, bioenergy, and biotechnological products. This approach relies on a combination of advanced sciences and technologies to achieve a balance between the environment, industry, and economy, in alignment with the 2030 Sustainable Development Agenda.

This vision considers data as the "new gold," emphasizing that the focus of the Fifth Industrial Revolution should be on the intelligent use of data to support sustainability throughout the product life cycle, while minimizing resource and energy waste. Sustainability in this context encompasses economic, social, and environmental dimensions, including reducing industrial waste, promoting a circular economy, and fostering renewable energy.

Although Fourth Industrial Revolution technologies have contributed to improving efficiency and reducing waste, they have not sufficiently mitigated the waste generated by data proliferation. Fifth Industrial Revolution technologies—such as Artificial Intelligence of Things (AIoT), advanced computing, and smart sensors—offer solutions to filter unnecessary data at the source, thereby reducing energy consumption, enhancing industrial efficiency, and promoting sustainability.

Challenges of the Fifth Industrial Revolution

It can be said that the world is still in the early stages of shaping the contours of the Fifth Industrial Revolution, as the full picture of its achievements has not yet crystallized. Significant time and effort remain necessary to achieve the desired integration and synergy between humans and intelligent machines, as well as among these machines themselves. In addition, potential challenges that may arise in the future could slow down the process of precisely defining the characteristics of this revolution in the near term.

In summary, a set of challenges can be identified that impose themselves in the very short term, with effects potentially extending into the short- and medium-term, particularly in developing countries. These include (Mehran, 2023, p. 5):

- Challenges related to digital infrastructure: Limited availability of high-speed, reliable communication networks and the Internet, sometimes coupled with insufficient security standards.
- Research and development challenges: The need for increased investments in scientific research and technological development to address current problems and prepare for future innovations.

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- Financial challenges: Limited local funding and the risks associated with external financing, which can affect the sustainability of technological projects.
- Educational and skills development challenges: Limited capacity to expand education in STEM fields (Science, Technology, Engineering, and Mathematics), as well as specialized and advanced disciplines related to artificial intelligence and its evolving applications.
- Labor market transformation challenges: The necessity to prepare for the emergence of new jobs that replace traditional roles, along with the associated risks of unemployment and its impact on macroeconomic indicators.
- Training and operational challenges: The need to design and implement advanced training programs that utilize the latest technologies and tools of the Fourth Industrial Revolution, while preparing for the requirements of the Fifth Industrial Revolution, ensuring that these programs reach the target groups effectively.
- Regulatory and administrative challenges: The need to establish modern regulatory and legislative frameworks capable of accommodating emerging technologies and managing them with flexible and efficient administrative methods.

Smart Digital Transformation

Smart digital transformation goes beyond simple digitization by integrating intelligent technologies such as AI, machine learning, IoT, and cloud computing, enabling continuous learning, predictive capabilities, and self-optimization, enhancing efficiency and sustainable innovation (Gurcan et al., 2023).

It evolves dynamically, responding to citizen needs across public and private sectors (Masoud, 2023, pp. 754–755). Practically, digital transformation improves public service efficiency by redesigning processes, changing organizational structures, and fostering behavioral and mindset shifts, leveraging technology to deliver faster, higher-quality services and ensure organizational sustainability (Margion, 20215; Masoud, 2023, p. 755)

As the concept of digital transformation has evolved, what is known as smart digital transformation has emerged as an advanced step toward the Fifth Industrial Revolution. This transformation goes beyond mere data digitization or traditional process automation. It integrates intelligent technologies such as artificial intelligence, machine learning, the Internet of Things, and cloud computing to create systems capable of continuous learning, predicting needs, and making more accurate and faster decisions. The result is a more flexible and efficient digital ecosystem, capable of improving service quality, supporting innovation, and enhancing institutional competitiveness in a rapidly changing world.

Digital Economy Business Models

In studying economic transformations, it is important to distinguish industrial and digital business models. An industrial business model relies on physical processes, technology, and operational infrastructure to achieve efficiency, growth, and cost optimization. In contrast, digital business models use digital methods to create value, target new or underserved markets, and leverage multi-sided platforms and network effects. They focus on digital operations, offering innovative services, improving processes, reducing costs, and enhancing competitiveness in evolving digital environments (Bukht & Heeks, 2018; Ksenofontova & Kerimova, 2018; Hess & Becker, 2024; Carvalho et al., 2021).

To illustrate the diversity of digital economy business models, several examples can be highlighted (Talin, 2024):

Ad-Supported Free Model: This model offers free services to users while generating revenue from advertisers who pay to display ads to that user base. It is prevalent in social media platforms and search engines. For example, Google provides free search services and tools such as Google Drive and Gmail, while earning revenue through targeted advertising based on user data. Similarly, Facebook and Instagram offer free social networking services while leveraging user data for personalized ads.

Freemium / SaaS Model: This model provides basic services for free while gating advanced features behind a paywall. Spotify offers a free version with limited features and ads, while Spotify Premium allows higher-quality, ad-free listening. Dropbox provides limited free storage and charges for additional space and features. Evernote follows a similar approach by offering basic note-taking services for free and charging for advanced features such as offline access or increased storage. The freemium model is widespread among SaaS services, beginning with free entry plans and converting users to paid subscriptions.

Usage-Based / On-Demand Model: Customers pay for the actual volume of services they use. For instance, Amazon Web Services (AWS) charges based on resources consumed (API calls, storage, servers). Ride-hailing

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services like Uber and Lyft charge based on distance and time, while some streaming services offer content on-demand for a fee. Freelance platforms such as Upwork and Fiverr also apply this model, charging based on time or service scope.

E-Commerce Model: This model focuses on selling physical products online. Companies like Amazon and eBay initially sold their own inventory, while Apple sells directly to consumers through its online store. Unlike marketplace models, traditional e-commerce emphasizes a one-way sales channel, where a company sells its own products directly.

Marketplace Model (Multi-Sided): This model connects sellers and buyers on a platform while charging transaction fees or commissions. Amazon and eBay have evolved into marketplaces, allowing third-party sellers to list products. Etsy connects artisans with buyers interested in handmade goods. The success of this model depends on balancing supply and demand simultaneously; imbalance can lead to platform failure. Crowdfunding is a specific form of this model, where resources or knowledge are pooled from the public for particular projects.

Ecosystem Model: This model offers an interconnected set of products and services that create network effects to enhance customer loyalty. Apple's ecosystem includes devices (iPhone, Mac, iPad), software (iOS, macOS), and services (App Store, iCloud). Google and Microsoft operate similarly by integrating operating systems, services, and cloud platforms. The strength of this model lies in the “lock-in” effect, making it difficult for users to switch to competing environments.

Access-over-Ownership / Sharing Model: Consumers use goods or services for a limited time without owning them. Examples include Airbnb for short-term lodging, Zipcar for hourly or daily car rentals, and Rent the Runway for temporary luxury clothing rentals. This model innovatively redefines ownership and consumption concepts.

Experience Model: This model enhances the value of physical products by integrating them with digital services and experiences. Tesla, for example, sells electric cars but also provides software updates that add features and improve performance. Nike+ Run Club offers a complete digital fitness experience, tracking performance, providing training, and connecting users with a community of runners.

Subscription Model: Customers pay recurring fees (monthly or annually) for continuous access to a product or service. Prominent examples include Netflix for video streaming, Adobe Creative Cloud for creative software, and Microsoft Office 365 for productivity. This model also applies to annual software licenses such as ERP systems.

Open Source Model: Software is provided for free with access to source code for community development. Revenue typically comes from additional services such as technical support, training, or premium versions. Examples include Mozilla Firefox, which earns from search partnerships, and Linux distributions like Red Hat, which generate profits from support and services.

Data Monetization Model: Revenue is generated indirectly, often without user awareness, by collecting, analyzing, and leveraging data for targeted advertising or commercial partnerships. Google provides Android for free but earns revenue from Google Play and data-driven ads, as highlighted by the Cambridge Analytica case regarding undisclosed data usage.

Crowdsourcing / Crowdfunding Model: This digital model gathers resources or funding from a large number of contributors online to support projects or products. Prominent platforms include Kickstarter and GoFundMe. This model can combine elements of other business models, such as ad-supported platforms, subscription models, or marketplaces.

Economic Impacts of Digital Transformation

Digital transformation is a multidimensional phenomenon that impacts the management of economic activities, communication methods, organizational culture, and human relationships, with clear effects on economic indicators such as GDP, productivity, and employment. Studies indicate that investments in digital transformation foster economic growth and improve key economic and social indicators.

Impact of Digital Transformation on Economic Growth

Innovation and the dissemination of knowledge constitute the core of economic growth, with long-term economic development closely linked to the accumulation of innovations driven by investment in research and development (R&D) and the provision of necessary incentives. According to Schumpeter’s theory of “creative destruction,” digital transformation is a force of this creative destruction that influences economic growth trajectories, positioning the most innovative players at the forefront of competitive markets. Imports and foreign direct investment contribute to technology transfer and the creation of a competitive environment,

encouraging companies to enhance their efficiency, while active financial markets provide the capital needed for the expansion and prosperity of startups. Moreover, addressing climate change challenges requires a "green technological revolution," objectives that digital transformation can support and accelerate (Aghion et al., 2021).

Although numerous studies have identified a positive relationship between economic growth and investments in digital transformation, other research suggests that this relationship may be negative in certain cases. For example, the introduction of a new investment commodity, such as personal computers in the United States during the 1990s, initially had a negative impact on economic growth due to the high adjustment costs imposed on the economy, which limited growth rates (Maryam et al., 2012).

Impact of Digital Transformation on Gross Domestic Product (GDP)

Digital transformation directly affects GDP by increasing public and private investments in the information and communication technology (ICT) infrastructure, as well as in high-tech sectors (Mićić, 2017). Most studies conducted across European countries indicate a positive correlation between rising investments in digital transformation—through the development of ICT in both public and private sectors—and key economic indicators, including GDP, productivity, and employment levels.

These studies show that the motivation for increasing investments stems either from the growing reliance on ICT in economic activities and daily social life or from government strategic policies and public initiatives aimed at developing the sector. The positive impact of these investments is particularly pronounced in high-income and developed countries compared to others.

A 2018 study conducted by the International Telecommunication Union (ITU) to measure the effects of fixed and mobile broadband and digital transformation on the economy from 2010 to 2017 in 75 advanced and developing countries—including Egypt—found a positive impact on GDP and productivity. The effect was relatively greater in developing countries, where broadband services had not yet reached the saturation levels observed in developed nations. The study further indicated that digital transformation strengthens the economy through the positive influence of institutional and regulatory variables on the growth of the digital ecosystem, which in turn contributes to GDP growth and enhanced productivity of production factors (Katz & Callorda, 2018).

Impact of Digital Transformation on Productivity

Productivity is defined as the efficiency with which an economy converts inputs into outputs. Digital transformation affects productivity through several channels. By investing in digital technologies, workers gain access to more advanced tools that enhance their ability to perform tasks efficiently, while production processes become more capital-intensive. Additionally, the declining cost of digital technologies encourages firms to upgrade their equipment and technological infrastructure, achieving cost savings and improving operational efficiency.

Other channels include the effective integration of capital and labor, most notably dynamic reallocation, which refers to an economy's ability to redirect inputs and outputs for optimal resource utilization. This can involve outsourcing or offshoring operations, as well as achieving economies of scale by producing greater output with fewer inputs. For instance, firms may find cloud computing or software-as-a-service (SaaS) more flexible and scalable than maintaining internal servers or on-premises software (D'Souza & Williams, 2017).

The effects of digital transformation on productivity typically manifest over the long term, as there is a time lag between technological innovation and the actual increase in productivity. This lag reflects the transitional periods needed to absorb and adapt to technological changes, which vary according to geographic, demographic, and labor market contexts. For example, the adoption of computer applications took time to positively impact productivity due to challenges in implementation, overly optimistic expectations, issues with returns distribution, and the concentration of productivity gains within a limited range of firms or sectors (Thabet, 2023).

Impact of Digital Transformation on Employment

Employment is affected by digital transformation in dual ways: it creates new jobs while displacing others, depending on workforce adaptability. Advances in robotics, smart technologies, and AI have transformed labor markets, work nature, and locations (Al-Hadi, 2021). Impacts include declining demand for low-skilled labor, growing demand for STEM and analytical roles, permanent job losses, remote work adoption, and substitution of humans by machines. The World Economic Forum (2020) predicts 85 million jobs displaced by 2025 and 97 million new tech-adapted jobs, with 44%

of the workforce ready for remote work. Digital transformation reshapes professions, particularly affecting low-wage and less-educated workers, highlighting the need for education reform, skill development, labour market dynamism, and enhanced social safety nets (Thabet, 2023).

Impact of Digital Transformation on Economic Policy

When digital transformation leads to higher productivity and growth in GDP—holding other factors constant—it redirects the course of fiscal and monetary economic policies. This is because digital transformation may generate new disparities in wealth and income distribution, leaving noticeable effects on macroeconomic dynamics, including widening skill gaps and the emergence of long-term unemployment, particularly among groups engaged in outdated or obsolete occupations (e.g., some older workers in traditional sectors). Consequently, governments need to design policies aimed at protecting intellectual property and patents, avoiding excessive tax burdens, securing affected groups, and creating new jobs aligned with the demands of the digital labor market (Aghion et al., 2021).

The effects of digital transformation also extend to monetary policy and the role of central banks, particularly through the proliferation of electronic payment methods and e-commerce. Electronic payment systems—one outcome of advancements in communication technologies—are designed to facilitate online banking and commercial transactions, enabling customers to pay for goods and services via smartphones or personal computers at lower costs and higher speeds. As these payment methods become more widespread, the volume of transactions using physical cash declines, affecting the money supply and weakening central banks' ability to control liquidity and the velocity of money, especially if private financial institutions assume the issuance of payment instruments. This may limit monetary authorities' ability to achieve policy objectives unless their capacity to monitor data and regulate these instruments is strengthened. Conversely, when strictly supervised by central banks, these systems can support monetary policy, although they also introduce additional challenges, such as risks of tax evasion and money laundering if legislation does not keep pace with technological developments (Al-Absi et al., 2020; Thabet, 2023).

E-commerce, meanwhile, involves executing sales and purchases of goods and services and exchanging information via the Internet, bypassing the temporal and geographic constraints of traditional commerce. With the increasing reliance on digital payments and cashless systems, the speed of transactions, and innovations such as cryptocurrencies, central banks must enforce stricter monetary policy frameworks and strengthen their capacity to control inflation rates in line with the emerging digital environment.

Impact of Digital Transformation on Income Distribution

The traditional economic system relies on wages for labor. However, the Fourth Industrial Revolution and digital transformation have increased investments in technology, innovation, and R&D, raising returns on knowledge capital relative to manual labor and concentrating income among fewer individuals, worsening inequality for low-skilled workers (Bossmann, 2016). To address this, governments should invest in education and digital skills, incentivize reskilling and employment through active labor policies (OECD, 2023; OECD Skills Outlook, 2019), strengthen social safety nets (European Commission, 2023), and support innovation and entrepreneurship ecosystems to ensure broader benefits from the digital economy (Capraro, 2023).

Impact of Digital Transformation on the Public Service Sector

Digital transformation in government includes e-government, smart government, and digital government. E-government digitizes traditional services and enables online access and electronic payments, simplifying procedures (Hunaidi, 2017). Smart government uses AI, mobile apps, and social media to provide interactive, citizen-focused services. Digital government extends further, promoting innovation, efficiency, and sustainable public administration. Overall, digital transformation enhances service performance by reducing citizen burdens, supporting reform, improving quality, accelerating payments, boosting technology investment, increasing efficiency, and minimizing corruption (Thabet, 2023).

Impact of Digital Transformation on Social Transformation

In studying economic transformations, it is important to distinguish industrial and digital business models. An industrial business model relies on physical processes, technology, and operational infrastructure to achieve efficiency, growth, and cost optimization. In contrast, digital business models use digital methods to create value, target new or underserved markets, and leverage

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multi-sided platforms and network effects. They focus on digital operations, offering innovative services, improving processes, reducing costs, and enhancing competitiveness in evolving digital environments (Bukht & Heeks, 2018; Ksenofontova & Kerimova, 2018; Hess & Becker, 2024; Carvalho et al., 2021).

Models of Digital Transformation Experiences

Amid the global acceleration toward digitalization, countries' experiences in digital transformation have become a source of inspiration and exemplary models. Some nations have achieved significant breakthroughs in this field, leveraging modern technology to enhance services and improve performance efficiency. In this context, we present pioneering examples of digital transformation experiences, highlighting various strategies and innovative visions that have contributed to building prosperous digital economies.

The Jordanian Experience

The Hashemite Kingdom of Jordan launched its Smart Government Program in 2001 under the supervision of the Ministry of Communications and Information Technology at the time, aiming to enhance digital services by coordinating the efforts of various ministries and institutions and utilizing multiple digital communication tools to develop planning mechanisms and deliver government transactions and services electronically (Talha, 2020, p. 27).

As part of institutional development, in May 2019, the ministry's name was changed to the Ministry of Digital Economy and Entrepreneurship—a strategic move aimed at supporting the digital transformation path, adopting the digital economy model, and fostering an entrepreneurial environment in the Kingdom. The new strategy focused on eleven core pillars, most notably: comprehensive development of Jordanians' digital and entrepreneurial skills, improving the quality of digital services, and digitizing payment and collection processes.

Given the limited natural resources, the government placed special emphasis on developing human capital and encouraging innovation and creativity as a key driver of economic growth, capitalizing on the young population and the digital skills prevalent in Jordanian society. This approach stimulated digital entrepreneurship and created new job opportunities, which positively impacted unemployment reduction (Ministry of Digital Economy and Entrepreneurship, 2021, p. 4).

The executive plan for Jordan's Digital Transformation Strategy for 2021–2025 includes a number of essential elements that form an integrated framework to achieve its ambitious vision. These elements aim to ensure the effective implementation of the defined strategic objectives through a set of procedures and enabling factors, which constitute the foundation for the successful advancement of the digital transformation path in the Kingdom. The components were organized to allow integration between technical, institutional, and legislative dimensions, ensuring alignment of national efforts with sustainable development requirements and the transition toward a digital economy, as illustrated in the table below:

Table (1): Strategic Enablers

Enabler	Description
Digital Infrastructure	Fifth generation (5G), Internet of Things (IoT), Artificial Intelligence (AI), Cybersecurity, ePayments, Digital Identity, National Addressing System
Digital Government Services	Interactive platform for data requests; onestop service; simple and fast services
Data	National information system; classification of government data; protection of personal data
Youth, Technology and Jobs	Developing digital skills; supporting the expansion of the digital economy and digital government services
Partnership with the Private Sector	Collaboration with the Ministry of Health, Department of Lands and Survey, Ministry of Higher Education, Income and Sales Tax Department
EParticipation	Econsultation; evoting; edecisionmaking

Change Management and Human Resources	Raising awareness and enhancing skills; fostering participation; knowledge management
Government Resources Management	Centralized government resource management system

Source: Ministry of Digital Economy and Entrepreneurship, National Digital Transformation Strategy 2021–2025.

The National Digital Economy Strategy adopted by the Jordanian government highlights efforts to develop the automation of e-government services. By reviewing Table (2), a concise overview can be provided of the services currently available, as well as those planned for future deployment through the unified government services portal, which aims to integrate and coordinate the services of ministries and other governmental entities in a comprehensive and efficient manner.

Table (2): Automation of Government Services

Category	**Value**
Targeted Government Entities	50 entities
Total Number of Services	2,464 services
Services with Application Programming Interface (API)	25 services
Services Without API	599 services
Services Being Digitized (Ongoing)	86 services
Non-Digitized Services (Pending Prioritization)	1,754 services

Source: Ministry of Digital Economy and Entrepreneurship, National Digital Transformation Strategy 2021–2025.

Based on the summary of the 2024 E-Government Survey: Accelerating Digital Transformation for Sustainable Development, it is evident that Jordan has made significant progress in its digital transformation journey, reflecting a strong commitment to implementing its national e-government programs.

In the Telecommunications Infrastructure Index (TII), Jordan's performance was notably high, indicating substantial development in this sector due to the significant increase in mobile subscriptions, the rising percentage of internet users, and the growth of fixed (wired) broadband subscriptions. These data suggest that the Kingdom is steadily advancing its digital infrastructure, highlighting the need for continued investment in expanding telecommunications networks, enhancing coverage, and developing fiber-optic projects to ensure the sustainability of digital transformation.

Jordan also achieved a high level in the Human Capital Index (HCI), reflecting the availability of a qualified workforce that has received education at all levels, from basic education to early stages of higher education. This has resulted in trained human resources equipped with the knowledge and skills necessary to support the e-government agenda and enhance its capabilities.

In the E-Participation Index (EPI), Jordan demonstrated advanced performance, reflecting policymakers' recognition of the importance of citizen and community engagement in the digital process. Such participation serves as a critical channel for generating innovative solutions to service, economic, political, social, educational, and health challenges. Moreover, e-participation enables decision-makers to formulate more accurate and effective policies based on real-time data.

Regarding the Open Government Data Index (OGDI), Jordan ranked very high, confirming the progress made in data accessibility and digital transparency. This reflects the state's commitment to openness and facilitating access to information, thereby providing broader opportunities for innovation and service development (E-Government Survey, 2024).

Overall, considering the strategies and enablers of digital transformation alongside the indicators from the 2024 E-Government Survey, Jordan is confidently advancing toward establishing itself as one of the leading Arab countries in digital transformation. The results show that the Kingdom possesses a developing digital infrastructure, qualified human resources, increasing openness to e-participation, and progress in government data accessibility and transparency.

However, sustaining this progress requires continued investment in telecommunications infrastructure, expanding its coverage, enhancing digital skills among the workforce, and embedding a culture of e-

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participation as a tool for planning and decision-making. Jordan's success in this path will support sustainable development and strengthen its competitiveness at both regional and international levels.

The Saudi Experience

Saudi Arabia has witnessed a qualitative leap in digital transformation within the framework of Vision 2030, evolving from one of the least oil-dependent societies globally into one of the fastest-growing emerging digital economies. The size of the digital economy reached approximately SAR 495 billion (USD 131.9 billion), representing about 15% of GDP by the end of 2023, alongside the creation of more than 381,000 jobs in the technology sector (Alojailet et al., 2023).

The Kingdom also achieved a landmark accomplishment by ranking first globally in the ICT Development Index 2025 issued by the International Telecommunication Union (ITU), which measures the level of digital development in 164 countries using a set of sub-indicators categorized under two main pillars: universal connectivity and effective connectivity. This achievement reflects the effectiveness of national policies and strategies aimed at sustainable digital transformation, contributing to attracting foreign direct investment and increasing the digital economy's contribution to GDP, which amounted to about SAR 495 billion in 2024, equivalent to 15% of GDP. Saudi Arabia's telecommunications and technology market is the largest and fastest-growing in the MENA region, valued at approximately SAR 180 billion in 2024. Statistics also indicate that mobile service subscriptions reached 212% of the total population, while the average monthly individual data consumption in the Kingdom exceeded the global average by threefold, reflecting intensive and efficient use of digital services (Communications, Space, and Technology Authority).

At the core of this transformation, strategic institutions were established, such as the Saudi Data and Artificial Intelligence Authority (SDAIA) in 2019 (SDAIA website) and the Digital Government Authority (DGA) in 2021, aimed at coordinating transformation efforts and developing a reliable information environment. A unified digital platform, "Nafath," connects more than 530 government and private entities and executed over 3 billion verification operations by November 2024.

From a planning and legislative perspective, the Kingdom adopted strategies such as the Smart Government Strategy (2020–2024) and the Digital Government Strategy (2023–2030) to enable smart governance, enhance the beneficiary experience, improve government performance, strengthen the legislative framework, and secure a trusted digital identity. Objectives were set to achieve advanced global digital rankings and provide distinguished digital government services (my.gov.sa).

Saudi efforts also included launching key digital platforms such as "Absher" for government services, "Tawakkalna," and "E'timad" for government procedures, in addition to advancing smart cities such as NEOM, eliminating traditional transport opportunities, and applying AI, intelligent connectivity, and augmented reality technologies. These initiatives reflect a strategic orientation toward building a globally competitive knowledge-based economy.

In the Health Sector, a notable achievement in Saudi Arabia's digital transformation is the establishment of the virtual hospital "Seha," which connects 170 hospitals and provides 29 primary specialized health services, along with 73 sub-specialized services. The hospital employs more than 150 physicians and has a capacity exceeding 480,000 patients annually. "Seha" is considered a priority initiative within the Health Sector Transformation Program, supporting Vision 2030, promoting a culture of virtual healthcare across health institutions, and delivering high-quality virtual health services at both national and international levels (moh.gov.sa).

Despite these accomplishments, the Kingdom faces several challenges. The most prominent is the shortage of digital competencies required to drive transformation, particularly in artificial intelligence, data analytics, and cybersecurity, including difficulties in adopting concepts such as DevOps due to a lack of institutional and organizational support (Alenezi, 2022). Another key challenge is establishing a clear legislative framework for artificial intelligence and data governance, which remains a major barrier to sustainable digital transformation.

The private sector is equally critical. Initiatives such as the Transcendence project aim to leverage local industries in AI by attracting investments and collaborating with global technology providers like Google Cloud. Additionally, new ventures like NextEra, a Saudi-capital technology services company under Aramco Digital and LTIMindtree, have been launched to support digital transformation and accelerate innovation.

Overall, digital transformation in Saudi Arabia constitutes a cornerstone of achieving the objectives of Vision 2030. It has contributed to the development of digital infrastructure, expanded e-government services, and strengthened the digital economy. This trajectory has created broader opportunities for innovation and enhanced governmental performance, thereby boosting

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the Kingdom's competitiveness at both regional and global levels.

The UAE Experience

The digital transformation journey in the United Arab Emirates (UAE) has been guided by the "We the UAE 2031" vision, which established a modern government model based on adopting cutting-edge digital technologies and developing flexible policies to enhance the country's global competitiveness. This vision emphasized the engagement of all segments of society in designing and developing government services, which improved service quality and strengthened the UAE's position as a global hub for investment and quality of life. The UAE also prioritized digital transformation in key sectors such as digital education, digital justice, and digital health, achieving leading global rankings in numerous international indices. The country ranked first globally in citizen-centered government services, first in public sector innovation, and first in government procurement of advanced technology products. Additionally, it ranked fourth globally in government digital transformation maturity, thirteenth in digital government development, and sixth in online citizen participation (Supreme Committee for Government Digital Transformation, 2023).

The UAE's 2025 Digital Transformation Strategy provides a comprehensive national framework to accelerate digital transformation across government sectors. The strategy focuses on enhancing user experience, facilitating access to digital services, strengthening cybersecurity, and protecting personal data. It was designed to align with national development goals through innovative digital solutions that enhance governmental efficiency and service quality. Key pillars of the strategy include:

- Providing a world-class digital infrastructure;
- Developing a unified digital platform with shared digital capabilities;
- Delivering integrated, easy, and fast government digital services tailored to user needs;
- Building national digital skills and capacities;
- Aligning the legislative environment to ensure a flexible and comprehensive digital transition;
- Enhancing the efficiency of the government work system.
- This approach reflects the UAE's commitment to establishing a sustainable, human-centered digital government model, strengthening its position among the top countries globally in smart government services (UAE Digital Government Strategy 2024-2025).

The UAE's digital transformation has progressed through successive phases marked by strategic programs and initiatives that solidified the national digital infrastructure and enhanced the country's status in smart government services. Key milestones include:

- 2010: Launch of the official UAE government portal (u.ae) as a unified access point for government services and information;
- 2011: Launch of the Mohammed bin Rashid Smart Learning Program to integrate modern technologies into education;
- 2013: Implementation of the smart (mobile) government concept at the federal level to provide services via smartphones and mobile devices;
- 2015: Launch of the Federal Electronic Network (FedNet) to provide a secure, unified infrastructure for data exchange among government entities;
- 2016: Introduction of the digital identity (UAEPass) as a secure, unified method to access e-services;
- 2018: Launch of a digital wallet using blockchain technology to enhance secure payment solutions;
- 2020: Declaration of the Year of the 50th, marking preparation for a new phase of development and transformation for the next fifty years (Telecommunications and Digital Government Regulatory Authority, 2020, p. 8).

The UAE's digital transformation experience represents a pioneering and comprehensive model. The country leads the Arab world in this domain and ranks highly on several global indices. This success is attributed to intensive strategic efforts by the UAE government through innovative initiatives aimed at achieving the national digital transformation strategy's objectives, including facilitating access to services across sectors and strengthening cybersecurity. The UAE continues its ambitious journey to maintain a global leadership position in digital transformation while ensuring

inclusivity and sustainability, making its experience an inspiring model for academic research and analysis.

The Singaporean Experience

Singapore's digital transformation journey began in the early 1980s, built upon a series of ambitious government plans and initiatives carefully designed to account for the country's specific economic and social contexts, while keeping pace with rapid technological advancements at each stage. This deliberate and methodical approach laid the foundation for Singapore's digital success, distinguishing it as a leading example both regionally and globally.

Table (3): ICT Initiatives in Singapore Vision and Key Objectives

Phase	Year	Initiative	Vision and Key Objectives
Phase 1	1980–1985	National Computerisation Plan	Development and use of ICT in public administration to provide better and more efficient services.
Phase 2	1986–1991	National IT Plan	Expanding government systems to the private sector to enable electronic data exchange, such as LawNet, MediNet, TradeNet.
Phase 3	1992–1999	Intelligent Island (IT2000)	Transforming Singapore into an intelligent island by developing ICT infrastructure and improving citizens' quality of life. Included the launch of the Singapore One project to expand broadband services nationwide.
		Infocomm21	Equipping and empowering a highly skilled ICT workforce and enhancing services, as part of developing Singapore as a global ICT hub and a digital economy and society.
Phase 4	2000–2015	Connected Singapore	Elevating information and communication technology (ICT) to new horizons, including the development of infrastructure to support wired and wireless networks and value-added services.
		Intelligent Nation (IN2015)	An extension of the intelligent island, focusing on building a knowledge and technology-based society and developing a

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			new generation of wired and wireless infrastructure.
Phase 5	2015		Improving citizens' lives, boosting economic productivity, and creating new economic opportunities through technology.

Source: Prepared by the researchers based on: (Yu-Min, 2021, p. 08) and (Toh, 2022, pp. 169–171)

Singapore is recognized as a digitally advanced country, owing to its continuous investments in ICT infrastructure, regulatory frameworks, educational and training programs, and its emphasis on innovation, research and development, and high-level technological skills and talent (International Trade Administration, 2024). Between 1980 and 2020, Singapore implemented major national ICT plans aimed at leveraging technology as a driver for economic and social development, building a competitive IT and tech industry, and establishing a knowledge-based economy. These efforts included workforce development in ICT, raising awareness of technology, upgrading infrastructure, and digitizing governmental and business processes (Toh, 2022, p. 169).

Singapore's digital transformation path began in the late 1980s through multiple programs, including the Civil Service Computerization Plan, IT2000 (1992), e-Government Action Plans (2000), iGov 2010 initiative (2006), and the e-Government Master Plan (2015). Later, the Smart Nation initiative emerged as a comprehensive program targeting full digital transformation across urban life, involving collaboration with the private sector, civil society, and citizens. To implement this vision, several institutional entities were established:

- Smart Nation Programme Office (SNPO) – 2014, under the Prime Minister's Office.
- Government Technology Agency (GovTech) – 2016, responsible for developing digital infrastructure.
- Smart Nation and Digital Government Office (SNDGO) – 2017, overseeing key projects such as the National Sensor Platform and National Digital Identity.

The government adopted an innovative vision to transform Singapore into a smart nation, integrating technological advancement with improved quality of life. This vision relies on ambitious national strategies and projects that leverage digital technologies to enhance public services, strengthen the economy, and improve citizens' well-being (Tan & Pan, 2023; Woo, 2018).

One of Singapore's flagship initiatives for becoming a smart nation is the GoBusiness platform, which streamlines interactions between businesses and the government. It provides quick access to electronic services such as licenses and grants through two unified digital portals, saving time and effort for companies. Another major initiative is the CODEX platform, a joint government–private sector digital platform designed to enhance data sharing and deliver public services more efficiently and cost-effectively.

The government places significant emphasis on electronic payments, launching services like FAST and PayNow to enable fast and secure financial transfers between individuals and institutions. Innovative solutions for merchants, such as the SGQR standard, allow payments via a unified QR code. In terms of accessing government services, the LifeSG app serves as a digital hub, enabling citizens to manage government services securely while ensuring strict data governance. The National Digital Identity (NDI) enables secure electronic transactions for both citizens and businesses through Singpass, a core enabler of the digital economy and international trade.

Singapore also invests in urban digital development, exemplified by Punggol Smart Town, which integrates work, education, and social life within a digitally advanced environment that fosters communication and innovation. On the smart infrastructure front, the SNSP platform collects data via sensors to analyze and address issues such as water consumption, public safety, and air quality. In smart mobility, Singapore focuses on a digital public transport system that analyzes passenger data, uses contactless ticketing, and develops autonomous buses to facilitate movement, particularly for seniors and persons with disabilities (Sipahi & Saayi, 2024, pp. 47–49).

Globally, in 2024, Singapore reinforced its leadership in the digital domain by ranking first in the IMD World Digital Competitiveness Index, outperforming 66 economies worldwide. This reflects the nation's excellence in human capital, advanced regulatory frameworks, institutional agility, and effective integration of digital technologies (IMD, 2024, p. 38). Additionally, Singapore achieved its best performance in over a decade in the Global Innovation Index (GII) 2024, ranking fourth globally

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among 133 economies while maintaining the top spot in Southeast and East Asia and Oceania. Singapore led in 14 out of 78 innovation indicators, including government effectiveness, ICT access, unicorn startups, and venture capital (WIPO, 2024, p. 154).

Chinese Experience in Digital Transformation

China represents a distinctive global model in digital transformation and advanced technologies, enabling significant improvements in national governance and competitiveness in public service delivery. Through comprehensive digital service platforms, China has simplified administrative approvals and introduced innovative service models via smartphone applications.

Over the past two decades, China has undergone rapid digital transformation, evident in its digital infrastructure, government services, and digital economy. This transformation evolved in several stages. In the late 1990s, China focused on building a robust digital infrastructure through initiatives such as the "Golden Projects", which aimed to electronically connect government agencies and enhance data flow among state institutions. The government also expanded internet access and computing resources for the public.

The first decade of the 21st century marked the emergence of e-government, where China adopted online platforms for public services, including taxation, licensing, and civil registration. Centralized portals were established to facilitate communication between citizens and the government, improving administrative transparency and reducing bureaucracy (Liu & Zhang, 2021; Zhang, 2023).

With the launch of initiatives such as "Made in China 2025" and "Internet Plus", China entered a new phase emphasizing digital transformation across industry and services. Leading tech companies like Alibaba, Tencent, and Baidu became key players in artificial intelligence, cloud computing, and e-commerce, raising the digital economy's contribution to over 30% of GDP.

In the current decade, China accelerated its digital transformation under the "Smart China" vision, applying AI, blockchain, and IoT technologies across health, transport, education, and financial services. The government also introduced the New Infrastructure plan, encompassing 5G networks and big data centers, to support sector-wide digital transformation. In 2022, China launched a National Digital Economy Development Plan (2022–2025), aiming to increase the digital economy's contribution to over 10 trillion yuan and enhance digital sovereignty by developing independent local operating systems and platforms (Zhou & Lun, n.d).

Study Results and Discussion

This section presents the key findings of the study and analyzes the impact of digital transformation on the economy, labor markets, and business models, while highlighting international experiences. It also examines the opportunities and challenges posed by digital transformation in the context of the Fifth Industrial Revolution, offering practical insights for governments, the private sector, and emerging economies to maximize the benefits of this transformation.

Key Findings

Evolution of Digital Transformation Across Industrial RevolutionsThe study revealed that digital transformation has progressed rapidly since the Fourth Industrial Revolution (4IR), characterized by the adoption of technologies such as artificial intelligence (AI), the Internet of Things (IoT), and industrial automation, which enhanced operational efficiency and productivity. However, this progress brought social challenges, including rising technological unemployment and widening inequality gaps. The Fifth Industrial Revolution (5IR) represents a qualitative shift aiming to rebalance human-machine collaboration through human-robot cooperation (Cobots), embedding sustainability in bioeconomy models, and integrating emerging technologies such as extended reality (XR), cognitive computing, and AI from an ethical and human-centered perspective.

Impact of Digital Transformation on Macro and Microeconomics

Economic Growth: Investments in digital infrastructure contributed to economic growth, especially in countries prioritizing digital transformation projects, such as the UAE and Jordan. Nevertheless, some studies indicate that high initial costs may temporarily slow growth during early transformation stages (Maryam et al., 2012).

Productivity: Digital technologies improved operational efficiency through data analytics and predictive maintenance tools, with positive returns becoming evident over the long term after the initial adaptation phase.

Labor Market: Digital transformation has fundamentally reshaped labor markets, reducing traditional jobs while creating new roles in data management and cybersecurity. According to the World Economic Forum

(WEF, 2020), digital transformation is expected to generate approximately 97 million new jobs while displacing 85 million by 2025.

Income Distribution: A widening gap between skilled and unskilled labor emerged, highlighting the need for educational and training policies that ensure digital inclusion and reduce economic disparities.

Digital Business Models

The digital revolution has led to fundamental changes in business models, with companies increasingly relying on:

- Freemium Models (e.g., Spotify, SaaS platforms, Dropbox).
- Sharing Economy Models (e.g., Uber, Airbnb).
- Data as an Asset (Data Monetization) (e.g., Google, Facebook).

International Experiences in Digital Transformation

Jordan: Achieved notable outcomes in digital government services and e-governance initiatives.

Singapore: A pioneer in early digital adoption, implementing programs such as Smart Nation 2025.

UAE: Attained advanced positions in government digital transformation through projects like UAEPass.

Saudi Arabia: Integrated digital transformation into Vision 2030 via initiatives such as NEOM and the Virtual Hospital.

China: Leveraged AI and robust digital infrastructure under initiatives like "Made in China 2025," driving industrial and service sector digitalization.

Discussion of Results

This section presents an analysis and interpretation of the study's findings on digital transformation. It highlights how technological advancements are reshaping economic structures, the challenges they pose in the context of the Fifth Industrial Revolution, and the opportunities they offer for emerging economies. The discussion aims to provide insights into the practical and strategic implications of digital transformation for governments, businesses, and society.

How Digital Transformation Creates a New Economic Pathway

Digital transformation reshapes the structure of the economy, shifting it from reliance on natural resources to a knowledge- and data-driven economy. New sectors have emerged, such as e-commerce, digital banking, and smart healthcare. It has also changed the rules of competition, making technological innovation the primary driver of growth rather than abundant labor.

Challenges in the Context of the Fifth Industrial Revolution

Despite the wide-ranging opportunities, digital transformation faces multiple challenges:

Technical: Inadequate digital infrastructure in some developing countries and cybersecurity threats.

Social: Risks of digital exclusion, unemployment among low-skilled workers, and the need for reskilling and upskilling.

Economic: Wealth concentration in the hands of large technology firms, and difficulties in aligning policies and regulations with rapid technological change.

Future of Digital Transformation in Emerging Economies

Digital transformation represents a strategic opportunity for emerging economies, as it can foster development through adoption of advanced technologies like AI and blockchain, enhancing financial and social inclusion while expanding access to digital services. However, these economies remain exposed to challenges, including overreliance on global tech companies and a widening digital divide between urban and rural areas. This necessitates comprehensive and proactive national policies to ensure balanced and inclusive benefits from digital transformation.

Overall, digital transformation is no longer optional; it has become a critical necessity driven by the Fifth Industrial Revolution. Early adopters, such as Singapore and the UAE, have demonstrated tangible benefits in economic growth and institutional efficiency. Yet, the success of this transformation requires a holistic response to the accompanying social and economic challenges.

Recommendations

Based on the findings of this study, it is clear that digital transformation is no longer optional but a strategic necessity. To maximize its benefits and ensure sustainable economic and social development, the following recommendations are proposed for governments, the private sector, and researchers, aiming to strengthen digital capabilities, foster innovation, and

address the challenges associated with digital transformation.

For Governments:

Expand digital infrastructure (5G) and cloud computing.

Reform education and training systems to meet digital skills requirements.

Update legal frameworks to protect data and encourage innovation.

For the Private Sector:

Adopt flexible business models based on data and digital platforms.

Invest in research and development to maintain competitiveness.

For Researchers:

Study structural changes in the labor market driven by artificial intelligence.

Analyze digital governance systems and compare them in the context of developing countries.

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