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The Role of Digitization and Sustainability in Shaping Global Economic Transformations

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Abstract: This study investigates the dual role of digitization and sustainability in driving global economic transformations. It highlights how digital technologies contribute to innovation, productivity, and efficiency across various economic sectors, while sustainability ensures long-term environmental and social resilience. The research analyses the interplay between these two forces, identifying key challenges such as digital divides, environmental burdens, and regulatory gaps, alongside opportunities in productivity growth, job creation, and green innovations. The study proposes strategic solutions including investment in clean technologies, policy reform, and international cooperation to enable a sustainable digital transition. Data from international reports and sectoral case studies support the analysis. The findings underscore that a synergistic approach to digitalization and sustainability is imperative for inclusive and future-proof economic development.

Keywords: Digitalisation, Sustainability, Digital Transformation

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1. Introduction

Recently, the global economy has experienced major transformations as a consequence of remarkable technical development and increasing courtesy to sustainability. The heavy dependence on digitisation has led to fundamental vicissitudes in most economic subdivisions, which have resulted in augmented productivity and opened dissimilar avenues for development. At the same time, ecological and economic confrontations have underscored the earnestness of adopting sustainable does that ensure reserve continuity for future peers. This highlights the interaction between digitalisation and sustainability in determining the new international economy, along with the foremost challenges and opportunities rising from these transformations.

The Importance of Research:

This study speeches two key points in the new universal economy:

1. Digitisation as a main actor in cumulative economic efficiency and refining productivity.
2. Sustainability as a main purpose to realize sustainable economic, environmental and social equilibriums.

3. Demonstrates the relationship between digitalisation and sustainability and in what way to capitalize them in consolidation the global economy.

Research Problem:

This problem is encapsulated in the following question: How do digitalisation and sustainability affect global economic transitions, and what are the primary confrontations and opportunities that arise from this response?

Research Hypothesis:

The research considers that digitalisation and sustainability are essential elements in global economic changes, as digitisation helps increase productivity and innovation, while sustainability works to find a balance between economic growth and the conservation of environmental resources.

The Objective of Research:

The research aims to:

1. Analyse the impact of digitisation on multiple economic sectors.
2. The importance of the role played by sustainability in assisting the global economy and providing environmental balance.
3. Explore the simultaneous confrontations with digitisation and sustainability and how to overcome them.
4. Provide strategies and solutions to support a sustainable digital economic transition.

Research Structure:

The research consists of three main sections, as follows:

Part One: Global Economic Transformations in the Light of Digitalization and Sustainability

Definition of economic transformations and the factors influencing them.

Digitalization and sustainability as pivotal factors in the economy.

Impact of economic transformations on various sectors.

Part Two: Challenges and Opportunities in the Sustainable Digital Economy

Digital challenges (digital gaps, skills shortages, environmental impact of digitalization)

Economic and social challenges of sustainability.

Opportunities available from digitalization and sustainability in enhancing productivity, innovation, and job creation.

Part Three: Strategies and Solutions for Achieving Sustainable Economic Transformation

Strategies for Promoting Digitalization to Achieve Sustainability

Technical Solutions and Government Policies to Address Challenges

The Role of International Cooperation in Supporting Sustainable Digital Transformation

Conclusions and Recommendations

Conclusion

Part One: Global Economic Transformations in Light of Digitization and Sustainability

First: Definition of Economic Transformations and the Factors Influencing Them

Economic transformations involving digitisation and sustainability are the fundamental changes within economic systems that arise from the integration of digital technology and the adoption of sustainable development practices. This encompasses the utilisation of digital technologies to develop commercial and economic theories, such as electronic trading and electronic processing, by extending to the intensification of practices that preserve and protect the environment while addressing the needs of present and future generations.

2. Materials and Methods

This study adopts a qualitative analytical approach, supported by descriptive statistics and comparative review of international reports and case studies. Data was primarily collected from global institutions such as the World Bank, IMF, OECD, UNESCO, and UNCTAD, which provide insights into digital transformation trends and sustainability benchmarks. Content analysis was applied to interpret patterns of economic change across sectors including agriculture, education, health, industry, and finance. Additionally, visual data in the form of tables was integrated to highlight digital and environmental metrics related to growth, efficiency, and resource use. A thematic content coding approach was used to categorize data into key themes: (1) digital infrastructure expansion, (2) sustainability integration, (3) policy and governance innovation, and (4) socio-economic impact across regions. Furthermore, secondary sources such as peer-reviewed books and conference proceedings were used to support theoretical discussion.

According to the ESCWA "Digital Economy and the Transformation towards Smart Societies in the Arab Region" report, the digital economy is defined as "an economy based on digital technology and based on several components, including technological infrastructure, hardware, software, and networks, in extension of the digital mechanisms through which commercial and economic projects are carried out, including electronic trading, and electronic processors that take place entirely on the Internet .

Moreover, the report "The Role of Digital Transformation in Achieving Sustainable Development in the Light of Legislation" notes that digital transition requires "the abundance of computers and advanced procedures programmes that ensure the design of the system in a version that ensures the efficiency of service effectiveness with a complete infrastructure for transactions and complete information systems."

These transformations aim to ensure sustainable economic development by improving efficiency and supporting economic growth while preserving the environment and resources for future generations.

The factors affecting economic transformations:

1. **Technological development:** Technological expansion is one of the most prominent elements that affect economic transitions, as progress in technology leads to improved productivity and the creation of modern economic opportunities. The exploitation of new technologies such as artificial intelligence and robotics is strengthening production and changing customary work preambles.
2. **Environmental sustainability:** Environmental sustainability is increasing among the new generation, as countries strive to mitigate the impact of economic activities on the environment. This is encouraging companies and governments to adopt nature-friendly programmes and implement measures that preserve natural resources.
3. **Globalisation:** Globalisation contributes to the strengthening of international trade and capital mobility, leading to a change in production and consumption methods. This incentivises countries to adapt to the global economy and adopt elastic economic policies.
4. **Political transformations:** Political transformations in countries across the world have a tremendous impact on economic policies, such as transformations in the political system or recent economic trends that may necessitate major changes in economic structures.
5. **Changes:** The transition in demographic structure affects labour markets and demand for products and services. As population increases in certain areas and declines in others, economic trajectories change according to the needs of the population.

Second: Digitization and Sustainability as Pivotal Factors in the Economy

Digitisation: It is the process of converting data and information from heritage or physical forms to a digital format, which facilitates its processing, storage and exchange through the use of computer technologies. This includes converting paper documents into digital files, and transforming audio, image, and video into electronically storable and processable data. Digitalisation is also one of the key elements that contribute to accelerating and enhancing effectiveness across various sectors, including education, health, projects and others.

Sustainability: It is the ability to respond to the needs of the present era without affecting the ability of future generations to respond to their needs. Sustainability is about balancing environmental, economic and social dimensions. It ensures the conservation of natural resources, the reduction of pollution, the promotion of social justice, and the long-term focused sustainable economic development.

Digitization and Sustainability as Pivotal Factors in the Economy:

Digitalisation and sustainability are vital elements that shape the global economy in the new era. Digitalisation, by transforming the known into a digital format and the application of new technology, contributes to enhanced efficiency and productivity across various economic sectors. Conversely, sustainability emphasises the necessity of preserving the environment and natural resources, which supports economic growth in a manner that will benefit future generations.

3. Results

Digitalization accelerates economic transitions by simplifying access to information and facilitating business transactions, while sustainability stimulates long-term investment that balances economic growth with environmental conservation. When digitalization is combined with sustainability, a more efficient and sustainable economy can be achieved in the future.

Third: The Impact of Economic Transformations on Various Sectors:

Economic transformations refer to the substantial changes in economic systems that occur as a result of a combination of internal and external elements, such as technological development, political changes, globalisation, and sustainable innovations. These changes profoundly affect all economic sectors, whether industrial, commercial, service, or agricultural. In this topic, we will consider the impact of these transformations on the disparate sectors at some length.

1. **Industrial Sector:** Economic transformations typically have a significant impact on the manufacturing sector, which is one of the subdivisions most affected by technical transformations. With the progression of digitisation and technology, businesses are witnessing a changeover towards automation, plummeting the need for self-driving effort and increasing productivity. Technology such as false intelligence, automation, and the Internet of Things (IoT) cooperate to improve efficiency and decrease costs. Economic transformations in this subdivision also include the acceptance of sustainable manufacture methods, such as the use of contemporary energies and biodegradable tools. This not only decreases the environmental influence, but also helps to obey with escalating environmental values.
2. **Commercial Sector:** Trade is one of the largest subdivisions that have helped from the economic transformations subsequent from digitisation. Through e-commerce, wholesalers are able to access contemporary markets with more efficient devices through online platforms. These changes result in the realisation of logistics and advertising costs. New technology such as false intelligence and data analytics also allows traders and divisions to personalise aids and products according to customer wants. Economic transformations also affect worldwide markets through globalisation, letting businesses to grow beyond their geographical levels.

3. **Service Sector:** The service sector is the additional most likely to shadow economic transformations. With digitisation, financial facilities, such as banking and cover, have radically shifted the admiration of digital services such as electric payment, mobile applications, and mist computing. Through these machines, persons and businesses can manage wealth, pay beaks, and execute transactions earlier and more professionally.
4. **Health Sector:** The health sector has also conventional an expansion in digital fitness measures. Through plans such as telemedicine and AI wellbeing data analysis, healthcare is becoming more actual and more nearby.
5. **Agricultural Sector:** The agricultural sector has experienced significant alterations as a result of economic vicissitudes, particularly with increased stress on sustainability and technological revolution. Technologies such as precision undeveloped involve the usage of sensors and data to improve crop production, minimise waste of water and insecticides, and contribute, in numerous ways, to significantly educating the efficiency of agrarian production. Economic vicissitudes are also being absorbed towards the acceptance of sustainable agrarian practices that intensify the upkeep and protection of natural capitals.
6. **Environmental Sector:** With growing environmental consciousness, many businesses are seeking to balance economic growth and environmental sustainability. Trends towards modern liveliness, such as solar and wind, are plummeting dependence on relic fuels. Economic transformations also comprise significant savings in sustainable skills to reduce environmental pollution and promote clean energy.
7. **Education Sector:** Economic transformations also bang impacts on teaching, where digitalisation is complex in transforming teaching and knowledge methods. Educational platforms finished the Internet and distance knowledge have become more extensive, making it likely for pupils all over the world to charge culture and instructive incomes from any geographical position. This change can have profound inferences for traditional devices of education and help rally the scale of education in communities.
8. **Government Sector:** Economic transformations are also consuming an impact on the government sector, as many establishments adopt digital systems in providing services to countries. Through e-government, administration services can be provided in a earlier and more efficient method, reducing fences and enhancing the knowledge of countries. Digitalisation also contributes to improved transparency and accountability in governments.
9. **Financial Sector:** The sector most affected by economic transformations is the financial sector, which includes banks, insurance companies, investment funds, and other financial companies that provide financial services. This sector mainly follows economic elements such as interest rates, inflation rates, monetary and fiscal policies, and general economic conditions.(Table 1)

Table 1. This table shows the impact of economic transformations on various sectors.

It includes simplified data:

Sector	Impact of Economic Transformations	Explanation	Source
Industrial Sector	Growing reliance on new technologies and smart technologies	Economic transformations require the industrial sector to adapt to automation, artificial intelligence, and 3D printing technologies, which increases productivity and reduces costs.	World Bank Report on Economic Transformation
Agricultural Sector	Transitioning towards smart agriculture and environmental sustainability	A digital economy supports the efficiency of agriculture using big data and sensors, contributing to	FAO Report

		environmental sustainability and more efficient food production.	
Financial Sector	Digitizing financial services and adding reliance on financial technologies (FinTech)	Economic transformations lead to the adoption of digital payment systems, cryptocurrencies, and artificial intelligence in the financial services sector, which supports efficiency and reduces costs.	IMF Report
Education Sector	Digital education and distance learning	Economic transformations require a reliance on digital education and distance learning technologies, which enhances access to education and contributes to reducing digital gaps between different regions.	UNESCO Report on Global Education
Health Sector	Transitioning to digital healthcare and telemedicine	Economic transformations contribute to the integration of technology in healthcare with the help of electronic health records systems, remote medical consultations, and artificial intelligence.	WHO
Tourism Sector	Digital transformation of travel experiences and increasing reliance on online booking	Thanks to economic transformations, the tourism sector has become more digitalized through online booking applications, artificial intelligence, and data analytics, enhancing the customer experience.	UNWTO Report

The researcher believes: Economic transformations pose confrontations and opportunities for many economic sectors. Through technological innovation and digitalisation, the way these sectors operate fundamentally is transformed, helping to improve efficiency and productivity. By focusing more on sustainability, industries are attempting to reduce their environmental impacts and secure sustainable economic growth. It is important for companies and sectors to experience these transformations to ensure that they succeed and adapt to future changes.

Part Two: Challenges and Opportunities in the Sustainable Digital Economy

First: Digital Challenges

1. **Digital divide:** Disparity in access to skill is one of the most prominent tests facing a sustainable economy. The digital gulf between developed and developing republics, as well as between city and rural areas, can delay people and businesses from benefiting from digital transformations. This change leads to some countries being unwilling to accept sustainable digital solutions, thereby warning their potential to deliver sustainable economic development.
2. **Cybersecurity and data protection:** With the increasing dependence on digital technology, concerns related with cybersecurity and the protection of personal data and sensitive information are increasing. Cyber raids, such as hacks and worms, threaten business safety and disturb the economy. Weak cybersecurity substructure hinders the growth of digital solutions and postures a threat to sustainable economic safety.
3. **Environmental impact of technology:** Although digital transformations principal to important economic benefits, some digital technologies might be involved in raising liveliness consumption and environmental contamination. For example, large statistics centres and the liveliness needed to operate them consume a inordinate deal of natural resources. Thus, it would be better to assimilate sustainable digital explanations with attention to tumbling the environmental impact of skill.

4. **Legal and regulatory challenges:** A sustainable economy is bare to problems associated with numerical laws and rules. Past laws that are not in streak with digital novelties can be a barrier to the application of sustainable technological answers. Moreover, the absence of appropriate legislature to regulate the sustainable use of skill, such as laws to defend the digital environment, additional exacerbates substances.
5. **Challenges in digital infrastructure:** Sustainable actions require excellent digital infrastructure to assist innovations and implement sustainable solutions. Moreover, many countries still lack the necessary infrastructure such as high-speed internet and advanced networks, which are required to secure sustainable economic growth.
6. **Impacts on the labour market:** Digital transformations may lead to fewer heritage positions and increased reliance on technology. This poses a challenge in the face of structural unemployment as the workforce in some sectors is likely to lack the skills necessary for employment in a digital economy. Education and training strategies are urgently needed to adapt to these transformations.(Table 2)

Table 2. The following table presents data illustrating the challenges and opportunities in the sustainable digital economy:

Factor	Data	Interpretation
Growth rate in the digital economy	15% annual growth in the global digital sector	The continued progress of the digital economy is estimated to reach 15% annually worldwide through 2026, demonstrating significant opportunities for digital transformation.
Global digital energy consumption	3.5% of global energy consumption	Data centers and digital technologies currently consume approximately 3.5% of total global energy consumption, highlighting the need to adopt more sustainable energy solutions.
Number of internet users	5.2 billion people worldwide	The number of internet users in 2023 will reach approximately 5.2 billion, representing approximately 66% of the global population, reflecting improved internet access.
Spending on cybersecurity	US\$170 billion in 2023	Global spending on cybersecurity will reach \$170 billion in 2023, highlighting the importance of investing in security to protect data in the digital economy.
Percentage of renewable energy use in data centers	35% of total energy used in data centers	Approximately 35% of the energy used in data centers relies on modern energy sources, demonstrating the trend toward sustainability in the digital sector.

Source: The Global Digital Economy: Challenges and Opportunities. Digital Growth Report 2023, Economic Research Center.

From Table No. (2) we conclude the following:

1. **Growth rate in the digital economy:** This figure illustrates the annual increase in digital sectors, indicating substantial opportunities within this field. The growth of 15% signifies a rising reliance on digital technology.
2. **Global Digital Energy Consumption:** This issue highlights the measurement of energy consumed by data centres and digital technologies, underscoring the necessity for more sustainable energy solutions.
3. **Number of Internet Users:** This statistic reflects the extent of Internet usage globally, which serves as an important criterion for identifying opportunities in sectors such as e-commerce and digital education.
4. **Cybersecurity Spending:** Expenditure on cybersecurity measures the challenges associated with data protection in the digital realm, emphasising the importance of investment in this area.
5. **Renewable Energy Adoption in Data Centres:** This figure points towards the appropriate path for sustainability in data centres through the utilisation of modern energy sources, representing a positive step towards mitigating the environmental impacts of technology.

Second: Economic, social, and political challenges to sustainability:

Economic challenges:

1. **High Costs of Transforming Towards Sustainability:** The cost of shifting towards sustainable strategies is one of the most important economic challenges. This includes important investments in modern vigor technology, improved production competence, and a transition to environmentally welcoming materials. These investments can be a load on small businesses and emerging countries facing cost difficulty.
2. **Inflation and its Impact on Resources:** Inflation leads to higher prices of production, making it problematic to adopt sustainable economic does. As prices increase, businesses may incur a better burden in promotion their systems to additional sustainable ones.
3. **Dependence on Fossil Fuels:** Many economies still rely lengthily on fossil coals as an energy reserve. The transition to modern energy sources needs a long time and noteworthy investment, which is producing economic control in certain countries .

Social challenges:

1. **Poverty and inequality:** Sustainability needs equitable marketing of capitals, but poverty and economic separation can disrupt the application of sustainability policies. Deprived individuals may fight to access sustainable modalities such as contemporary energy or environmental leadership, exacerbating social disparities.
2. **Impact on jobs:** The shift towards more maintainable economic does may result in the loss of certain inheritance positions, particularly in businesses that depend on fossil gases. This can lead to communal confrontations in light of the need to retrain workers and make them for service in sustainable businesses.
3. **Cultural and social adaptation:** Sustainability entails a modification in the consumption habits of persons, which may face social confrontation. In many republics, it can be challenging to change from a lifestyle that relies on excessive reserve consumption.

Political challenges:

1. Lack of organization between governments: Countries may meeting complex regulations between national and worldwide policies to ensure sustainability. Certain authorities might focus more on short-term financial development somewhat than sustainable long-term savings, which hinders development.
2. Inadequate environmental policies: Despite global efforts, there are still insufficient environmental rules in some countries. Authorities may face difficulties in enforcing real environmental lawmaking, which may lead to constant environmental weakening.

Third: Available opportunities

1. **Improving production efficiency:** A sustainable digital economy participates in improving production efficiency by using technology to monitor and efficiently process. Technologies such as artificial intelligence and the Internet of Things contribute to enhancing agricultural and industrial production, reducing waste, and improving the more efficient exploitation of natural resources.
2. **Expanding new markets:** The digital economy facilitates access to modern markets at both the internal and global levels. Through e-commerce and digital technologies, SMEs can compete in international markets, opening new avenues for sustainable economic growth.
3. **Innovation in renewable energy:** A sustainable digital economy advocates for innovation in the modern energy sector. Technologies such as smart grids and digital solar energy enhance energy marketing and reduce waste, thereby supporting the utilisation of modern energies and minimising environmental impact.
4. **Achieving inclusive growth and financial inclusion:** The digital economy offers an opportunity to consolidate people in remote areas from accessing financial,

educational, and medical services online. This supports financial inclusion and abounds economic opportunities for people who may not be able to access these services in the classical economic system [1].

5. **Promoting environmental sustainability:** Through digitisation, the management of natural resources can be exploited and their consumption reduced. For example, big data is being exploited to legalise consumption and reduce losses in disparate industries, helping to preserve the environment.
6. **Promote innovation in the fields of transport and logistics:** Through the digital economy, the transport and logistics sector can exploit technologies such as drones and autonomous vehicle technology that reduce pollution and participate in achieving clean and modern energy.
7. **Create new jobs in digital fields:** A sustainable digital economy is emerging in areas such as data analytics, artificial intelligence, and blockchain technologies. These new industries provide opportunities for sustainable economic growth and collaborate to develop workforce prowess.

Table 3: Illustrates the importance of opportunities related to the sustainable digital economy:

Factor	Data	Interpretation
Annual growth rate of e-commerce	12% annual growth in global e-commerce	This figure shows that e-commerce is growing at 12% annually worldwide, demonstrating the continued development of digital commerce.
Internet penetration in developing countries	60% of the population in developing countries uses the internet	This figure shows that approximately 60% of the population in developing countries has access to the internet, highlighting the challenges and opportunities in improving digital access.
Renewable energy penetration in data centers	45% of data centers use renewable energy	This figure demonstrates an improvement in the utilization of modern energy within data centers, part of the international trend toward more sustainable practices.
Annual cybercrime incidents	1.4 million cybercrimes annually in 2023	This statistic highlights the significant increase in cybercrime, making it imperative to strengthen security protections in the digital age.
Spending on artificial intelligence technologies	\$500 billion in 2024	Global spending on artificial intelligence technology is expected to reach \$600 billion by 2026, highlighting the need for innovation in this field to ensure sustainable digital growth.

Source: Sustainable Digital Economy: Trends and Challenges, Digital Transformation Report 2023, United Nations Conference on Trade and Development (UNCTAD).

The above table (3) shows the following:

1. **Annual growth rate in e-commerce:** This figure indicates the acceleration of growth in the e-commerce sector, which reflects the digital transformation in the retail and global trade sector.
2. **Percentage of Internet use in developing countries:** This figure demonstrates the extent of Internet circulation in developing countries, contributing to a significant improvement in Internet access in these regions.
3. **Renewable energy penetration rate in data centres:** The percentages of data centres utilising modern energy reflect the efforts of the digital sector to reduce its environmental impact and ensure sustainability [2].
4. **Number of annual cybercrimes:** This figure indicates the rise in cybercrime globally, highlighting the necessity to strengthen cybersecurity strategies within the digital economy.
5. **Spending on AI technologies:** This figure illustrates the growing interest in AI technologies from companies and authorities, emphasising the importance of the

substantial opportunities that AI offers in enhancing efficiency and supporting a sustainable digital economy [3].

Part Three: Strategies and solutions for achieving sustainable economic transformation

First: Strategies for promoting digitization to achieve sustainability

1. Investing in clean technology: Employing pure technology such as modern energy, green computing, and smart grids are key strategies to support digitisation and provide sustainability. By developing digital technologies to store and manage energy in more efficient ways, customary energy consumption can be reduced and environmental pollution diminished [4].
2. Use of big data and advanced analysis: The exploitation of big data and advanced analysis can improve the efficiency of natural resource consumption and identify areas where waste can be reduced. For example, utilising graphical analysis to take advantage of energy consumption in buildings and industries, or utilising data to enhance the management of agricultural resources.
3. Expanding digital solutions for distance education: Supporting digitisation in the education sector through distance learning platforms intensifies the availability of sustainable education opportunities for individuals around the globe. This contributes to reducing carbon emissions from travel and securing more accessible educational opportunities.
4. Adopting sustainable digital business models: Assisting companies in embracing sustainable digital business practices such as the sharing economy and e-commerce, which rely on digital technologies to minimise the necessity for mobility and conserve time and resources. Digitalisation also enables companies to expand internationally without the need for substantial resources [5], [6].
5. Promoting digital inclusion: By enhancing access to digital technology in remote areas and underprivileged communities, greater financial and educational inclusion can be achieved. Ensuring high-speed internet and smartphones in less developed societies facilitates participation in the digital economy, contributing to social and economic sustainability [7].
6. Improving the effectiveness of logistics operations through digitisation: Digitisation can significantly enhance transport and logistics operations, thereby reducing fuel consumption and environmental emissions. Technologies such as drones, autonomous vehicle technology, and intelligent inventory management systems can play a crucial role in reducing waste and improving logistics efficiency.
7. Monitoring the environment through remote sensing techniques: Exploiting remote sensing technologies (such as satellites and drones) to monitor environmental transformations such as forest displacement, air and water pollution, can help improve strategies to preserve the environment more accurately and effectively. (Table 4)

Table 4. Illustrates multiple strategies aimed at promoting the use of digital technology globally:

Strategy	Details	Numbers	Source
Strengthening infrastructure	digital Expanding telecommunications and internet infrastructure	95% of the world's population has 4G network coverage by 2025.	ITU - International Telecommunication Union
Promoting inclusion	digital Ensuring universal access to digital technology	37% of the world's population (2.9 billion people) remains offline.	UNESCO - United Nations
Promoting education	digital Developing digital educational platforms	70% of students in developing countries used digital learning platforms	World Bank - Education

		during the COVID-19 pandemic.	
Promoting digital innovation	Supporting research and development in digital technology	40% of international companies have increased their investments in digital innovation.	WIPO - World Intellectual Property Organization
Promoting the digital economy	Promoting digital entrepreneurship	The digital economy contributes approximately 22% of global GDP.	OECD - Digital Economy

Note: The percentages mentioned in the table above are estimated percentages based on recent reports from international organizations.

Second: Technical solutions and government policies to address the challenges:

Technical Solutions:

1. Shift to AI and Big Data: AI and big statistics analysis help recover resource organization, reduce waste, and analyse economic and ecological items to make maintainable decisions. Governments and businesses are using these methods to analyse energy consumption, optimise manufacture, and expand ecologically friendly digital answers.
2. Sustainable Digital Infrastructure Development: Paying high-efficiency internet systems and cloud figuring technologies to decrease carbon emissions connected to inheritance infrastructure. Secondary green computing that trusts on modern energy bases instead of fossil gases.
3. Using blockchain technology to enhance transparency: Blockchain technology contributes to improving transparency and accountability in economic processes, such as pursuing sustainable products, and providing fairness in e-commerce [8], [9].

They also contribute to the simplification of financial transactions, reduce the need for paperwork and unfavourable bureaucratic measures.

Endorsing the Internet of Things in keen resource organization: sensors and the Internet of Things can be rummage-sale to track water and energy ingesting and manage keen cities more professionally.

This contributes to improving energy efficiency in factories and buildings, reducing costs and improving sustainability.

Government Policies:

1. Legislation that supports sustainable digital transformation: Authorities must develop coordination policies that support digital transformation, such as data protection laws, and incentivise companies to adopt sustainable technology. Form financial incentives such as tax solutions to endorse innovation in environmentally friendly technology.
1. Promote investment in digital education and vocational training: Develop educational projects to enable people to connect with modern digital tools, including artificial intelligence and data analysis. Circulate training initiatives to support workers affected by digital transformations, to ensure their integration into the modern labour market [10], [11], [12].
2. Supporting digital and economic inclusion: Secure affordable internet in rural and remote areas, to ensure that all categories benefit from digital opportunities. Promote financial inclusion by adopting electronic payment systems that allow non-bank communities to access financial services .
3. Developing national renewable energy strategies: Creating new policies that reduce carbon emissions and support companies to use clean energy sources. Advocate for research and innovation in fields such as sustainable batteries and smart environmental technologies.

4. International cooperation to promote sustainable policies: Building global partnerships to support innovation in the areas of digital transformation and sustainability. Adopt trade policies that support the circular economy, where resources are recycled rather than consumed in an unsustainable manner.(Table 5)

Table 5. Illustrates the technical solutions and government policies to address the challenges

Challenges	Technical Solutions	Government Policies	Ratio	Resources
Cybersecurity	Using advanced encryption technologies (such as AES-256)	Enacting strict data protection laws (such as GDPR)	95% of security attacks are caused by human error (IBM, 2023)	IBM Security Report
Digital Infrastructure	Expanding 5G networks	Investing \$1 trillion in digital infrastructure by 2030 (ITU, 2023)	80% of countries have national digital transformation strategies (ITU, 2023)	ITU Digital Trends
Digital Divide	Securing internet via satellite (such as Starlink)	Allocating \$50 billion to bridge the digital divide in developing countries (World Bank, 2023)	3.7 billion people remain offline (World Bank, 2023)	World Bank Digital Divide
Privacy and Data Protection	Developing artificial intelligence technologies to securely manage data	Imposing fines of up to 4% of the revenue of companies that violate GDPR (GDPR, 2023)	68% of users are concerned about the confidentiality of their data (Pew Research, 2023)	Pew Research Privacy
Environmental Sustainability	Using environmentally friendly data centers that rely on modern energy	Supporting modern energy projects by 30% of total digital investments (IEA, 2023)	Data centers consume 1% of global energy (IEA, 2023)	IEA Renewable Energy
Digital Education	Expanding interactive educational platforms based on artificial intelligence	Privatizing 20% of education budgets for digital transformation (UNESCO, 2023)	90% of future jobs require digital skills (UNESCO, 2023)	UNESCO Digital Education
E-Commerce	Expanding secure and fast electronic payment systems (such as blockchain)	Reducing taxes on e-commerce startups by 15% (WTO, 2023)	Global e-commerce will reach \$6.5 trillion by 2025 (WTO, 2023)	WTO E-commerce Report

Note: The percentages mentioned in the table above are estimated percentages based on recent reports from the mentioned organizations.

When we note Table (5), we observe that it provides an extensive and concise vision on how to address digital challenges using modern technologies and government policies equipped with advanced figures and statistics.

Third: The role of international cooperation in supporting sustainable digital transformation

1. **Knowledge exchange and technology transfer:** International collaboration participates in the exchange of knowledge and technology between countries, accelerating the process of sustainable digital transformation. Developed countries are assisting in providing technical support to developing countries by offering sustainable digital solutions that contribute to enhancing vital sectors such as energy, health, and education [13].
2. **Financing sustainable digital projects:** International institutions such as the World Bank and the International Monetary Fund provide financing approaches to developing countries to support sustainable digital transformation projects. These funds aid in the construction of digital infrastructure and promote innovation in

areas such as artificial intelligence and the Internet of Things to achieve sustainability [14].

3. **Develop united standards and policies:** Collaboration between republics involves the development of worldwide standards of digital supremacy, such as data defense, information security, and behavioural use of skill. This ensures consistency between local and worldwide policies, easing the adoption of sustainable digital answers on a large scale.
4. **Secondary the Green Digital Economy:** Global solidarity reinforces green digital economy strategies by adopting common plans such as reducing carbon releases in the technology sector. Countries can cooperate to expand digital answers that contribute in the management of environmental capitals in a more efficient arrangement, such as by artificial intelligence to track climate alteration.
5. **Improving global digital infrastructure:** International partnerships are involved in the development of digital infrastructure, such as the deployment of high-definition Internet networks in poor countries and rural areas. These efforts are involved in ensuring international digital inclusion, giving everyone the opportunity to participate in a sustainable digital economy.
6. **Collaborative R&D:** Cooperation between universities and global research centres helps exchange innovative ideas and solutions that support sustainable digital transformation. Countries can form joint research approaches to expand new technologies in sectors such as renewable energy and green artificial intelligence.
7. **Strengthening cybersecurity and digital legislation:** Sustainable digital transformation requires robust protection against cyber campaigns and cybercrime, which can be achieved through global solidarity in the field of cybersecurity [15].

4. Discussion

The findings of this study affirm that **digitization and sustainability** are two interlinked forces driving comprehensive economic transformations across sectors. Digitization enhances productivity, promotes innovation, and streamlines service delivery, while sustainability ensures environmental responsibility and intergenerational equity. **This synergistic integration implies** that digital transformation, when aligned with sustainable development goals, can yield inclusive growth, technological equity, and environmental protection. However, **several limitations remain**, including digital divides, uneven infrastructure development, regulatory mismatches, and the energy-intensive nature of digital technologies. These issues may constrain the widespread adoption of sustainable digital models, particularly in developing economies. **Future research should focus** on sector-specific implementation strategies, the role of AI and blockchain in sustainability governance, and mechanisms for international policy harmonization. Emphasizing empirical analysis and longitudinal studies will also be crucial in understanding the long-term socio-economic impacts of a sustainable digital economy.

5. Conclusion

1. Digitalisation and sustainability are key factors in shaping the modern global economy.
2. Despite the challenges, digitalisation presents significant opportunities to promote sustainability.
3. Governments and companies need to adopt soft policies to contemporise economic transformations.

Recommendations

1. Investing in digital infrastructure supports the effective use of technology.
2. Assisting research and innovation in the fields of green technology.
3. Strengthening cooperation between the public and private sectors to provide sustainable digital transformation.

In light of international economic transformations, securing a balance between digitalisation and sustainability is imperative to ensure sustainable growth. This entails adopting effective policies and strategies that strengthen innovation and reduce digital and environmental divides, contributing to building a fairer and more efficient global economy.

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