

## Article

# Impact of Digital Transformation toward Sustainable Development

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**Abstract:** The rapid advancements in digital technologies have prompted organizations to embrace digital transformations (DTs) in order to enhance efficiency, gain a competitive advantage, and achieve long-term sustainability objectives. However, the successful adoption of innovative digital technologies necessitates the careful consideration of various factors, such as stakeholder engagement, resource allocation, risk mitigation, and the availability of resources and implementation support. This study examines the sustainable adoption of innovative digital technologies (DTs) within digital transformations. The data for this study were collected from 760 stakeholders through a questionnaire survey and analyzed using SPSS software (Version 27). This study's results underscore the significance of considering the efficiency of the transformation process and the long-term sustainability outcomes for organizations. The findings of the analysis clarify that integrating sustainability principles and DT has a positive impact on the effectiveness of the transformation, as indicated by environmental, social, and economic performance indicators. This study's novelty lies in its focus on incorporating sustainability principles into the digital transformation process. The results of this study demonstrate that organizations' long-term sustainability outcomes are enhanced when their digital transformation goals align with the Sustainable Development Goals (SDGs). The purpose of this study emphasizes the importance of arranging digital transformations with sustainable objectives to ensure the overall success and longevity of transformation efforts.

**Keywords:** digital transformation; sustainable development; digital technology; stakeholders; economy; governance



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## 1. Introduction

The rapid development of the technological landscape has made digital transformation (DT) an essential driver for organizational growth and success [1]. As businesses aim to remain competitive and adapt to evolving customer needs, the sustainable adoption of innovative digital technologies has emerged as a critical aspect of their digital transformation journey [2]. The concept of continuous digital transformation involves responsibly and durably integrating digital technologies into business processes while considering their environmental, social, and economic impacts. Achieving the sustainable adoption of these innovative digital technologies requires organizations to carefully evaluate their environmental footprint, optimize energy consumption, and minimize e-waste [3]. It also involves addressing the social implications of technology adoption, such as privacy concerns, ensuring inclusivity, and promoting digital literacy among employees and customers. By embracing sustainable practices in the adoption of innovative digital technologies, organizations can not only attain operational efficiencies and cost savings but also contribute to the greater good by reducing their carbon footprint, supporting social development, and driving economic growth [4].

### *1.1. Digital Transformation in Today's Hypercompetitive Environment*

In today's hypercompetitive environment, businesses are encountering unprecedented challenges and opportunities due to rapid technological advancements. Digital transformation (DT) has emerged as a key strategy adopted by organizations to navigate this landscape [5]. DT involves the integration of digital technologies into all aspects of business operations, fundamentally changing how companies deliver value to customers and remain competitive in the market. In this era of constant innovation and disruption, DT has become imperative for businesses to survive and thrive [6]. DT enables businesses to gain a deeper understanding of their customers and engage with them in a more personalized manner, fostering stronger relationships. It also creates new avenues for revenue generation, such as e-commerce platforms and digital marketplaces [7]. Additionally, digital transformation empowers employees by providing them with tools and technologies that enhance collaboration and foster innovation.

### *1.2. Digital Technologies in Digital Transformation*

Digital technology has emerged as a transformative force, revolutionizing various aspects of our lives and reshaping the way businesses operate [8]. In the context of DT, digital technology serves as the backbone for organizational change and innovation. It enables businesses to streamline operations, optimize resource allocation, and create new value propositions [9]. By using digital tools and platforms, organizations can collect and analyze vast amounts of data, enabling data-driven decision-making and personalized experiences for customers. Moreover, digital technology facilitates agile and collaborative workflows, breaking down traditional barriers and enabling organizations to adapt quickly to market demands [10]. It offers the potential to revolutionize business models, redefine customer engagement, and drive operational excellence. Organizations that effectively harness the power of digital technology in their digital transformation journey are well-positioned to thrive in the digital era.

### *1.3. Sustainable Development Goals*

One of the most important components of accomplishing the Sustainable Development Goals (SDGs) of the United Nations is the sustainable adoption of innovative digital technologies in digital transformation. A collection of 17 global goals known as the SDGs was created to solve urgent social, economic, and environmental issues and build a sustainable future for all [11]. Several SDGs directly align with the topic of the sustainable adoption of innovative digital technologies in DT. Goal 9, for instance, aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and develop innovation. This goal emphasizes the importance of developing digital technologies to drive economic growth, enhance productivity, and support sustainable industrial practices [12]. Goal 7 focuses on ensuring access to affordable, reliable, sustainable, and modern energy for all. Figure 1 shows the sustainable development sectors. By embracing the sustainable adoption of innovative digital technologies in digital transformation, organizations can contribute to these SDGs while driving positive change in areas such as education, healthcare, agriculture, and environmental conservation [13].

Research questions and objectives:

RQ1: How can digital transformations contribute to social sustainability?

RQ2: What are the uses of digital transformation in the long-term sustainability of an organization?

RQ3: What are the factors that influence the resource allocation and risk mitigation of sustainable digital transformations?

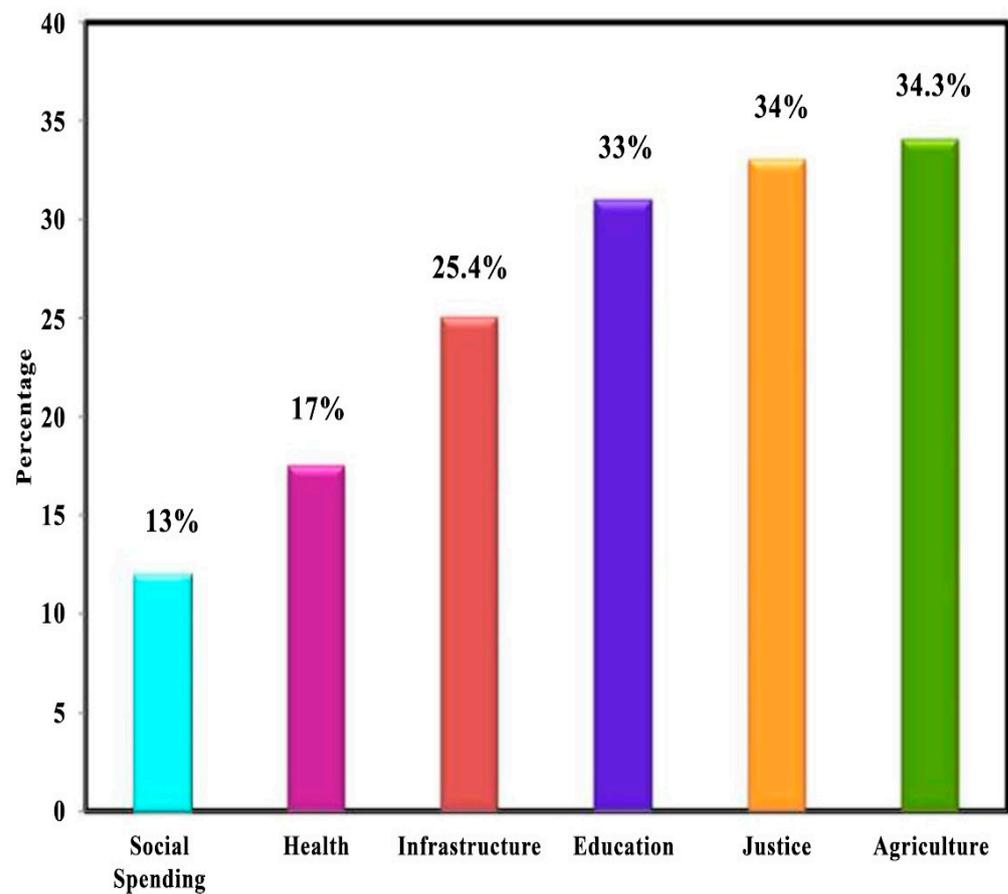


Figure 1. Sustainable development sectors.

#### 1.4. Contributions

This study's main contributions are as follows:

- Explores the sustainable adoption of innovative digital technologies in digital transformations and its implications for organizations;
- Investigates the consequences of sustainable digital transformations on organizations' long-term sustainability goals;
- Explores the importance of effectively engaging stakeholders throughout the digital transformation process;
- Examines the resources and support required for organizations to successfully implement sustainable digital transformations.

The novelty of this study is the focus on incorporating sustainability principles into the process of digital transformation. This study recognizes that while DT can bring about efficiency improvements and competitive advantages for organizations, it is important to consider long-term sustainability outcomes and address potential challenges related to stakeholder engagement, resource allocation, and risk mitigation.

The remaining sections of this study are arranged as follows. The literature review is in Section 2, the theoretical framework of the study is in Section 3, the conceptual framework is presented in Section 4, the methodology is proven in Section 5, the study results are explained in Section 6, and finally, the paper is concluded in Section 7.

## 2. Literature Review

The findings of earlier research studies that are pertinent to the current study are summarized in this section. This section discusses digital transformation and sustainability, with a constant emphasis of its adoption in DT, and implementing innovative technologies

in digital transformation. The review also identifies the research gaps that the current research needs to fill.

### *2.1. Digital Transformation and Sustainability*

The world has undergone numerous changes over the years as a result of industrial development and technological advancements. At the moment, markets are characterized by volatility, uncertainty, complexity, and ambiguity, which are the primary forces behind a phenomenon known as digital transformation. The interrelation between sustainability and DT at the corporate level was reviewed by Gomez and Gonzalez in 2022 [14]. The research used a methodical review of 89 published studies. Comprehensive content analysis filters were applied. The study found that a framework for research that sees DT as a precursor and driver of sustainability is achievable. For businesses to survive the digital revolution, the report advised them to (i) increase digital skills and (ii) balance their economic, (iii) environmental, and (iv) social implications. The risks and opportunities that information and communication technologies present for environmental sustainability, as well as the political awareness of these risks and opportunities, grow more important as their use in industrial production increases. The policies in the industrial and digital sectors of three East Asian and Pacific Island countries as well as four Sub-Saharan African countries were evaluated by Kunkel and Matthes in 2020 [15] regarding the anticipation-concerning effects of ICTs on professions for environmental constants. The analysis showed that policies emphasize a wide variety of hazy expectations and place a greater emphasis on the positive benefits of information and communication technology use.

### *2.2. Importance of Sustainable Adoption in Digital Transformation*

Companies face enormous challenges as a result of DT, which transforms industries and necessitates the development of new change-adoption strategies. Businesses and industries are going through a significant transformation that will result in digitized business operations. Companies are being forced to develop completely new strategies as a result of digitization, which is also driving all business processes. Ukko et al. (2019) [16] investigated the connections between financial performance, a sustainability strategy, and a digital business strategy. Two management and operational skills are necessary, according to the report, to put a digital business plan into practice. The results demonstrated that a sustainability plan facilitates the interrelation between a digital company strategy and financial performance. According to the study, the sustainability strategy supported the link between managerial competence and financial performance. However, there was a negative correlation between operational capability and financial performance when using the sustainability strategy. Universities have undergone several significant changes in recent decades as a result of social and technological trends toward digitalization. Currently, a paradigm shift in which technology is conceived as a complex and interconnected environment that enables digital learning is related to the adoption of technologies by universities. Abad et al. (2020) [17] analyzed the international research trends of the effects of managing the DT of higher-education sustainably. The study found that there is a significant impact on the adoption of new technologies in higher education.

### *2.3. Implementing Innovative Digital Technologies for Digital Transformation*

Digitally enabled enterprises are supported by new information and communication technologies (ICTs), often known as new technologies, which increasingly provide significant prospects for growth. The study by Loonam et al. investigated the procedures needed to implement DT inside conventional businesses. It identified four key themes that companies should adopt when implementing practical changes to digital business models (Loonam et al., 2018) [18]. According to Bican and Brem (2020) [19], digitalization significantly contributes to the UN Sustainable Development Goals. Future economic and environmental challenges cannot be resolved sustainably without the transformation of existing businesses. To develop a general understanding and definition that would serve as

the foundation for the interrelations within a conceptual framework, the study examined the prior literature. Based on a systematic literature review within the fields of management and economics, the research identified seven key terms related to digitalization, namely, digital, business model, digital business model, digital technology, digital innovation, digital transformation, and digital entrepreneurship.

#### *2.4. The Process of Integrating Spatial Data Infrastructures (SDIs) into the Information Infrastructure of EU Countries Is Achieved by Decrees*

Spatial data infrastructure (SDI) involves the collection of innovations and technologies, organizational arrangement, and the strategies that supply a foundation for spatial data discovery. SDI mainly includes GPS, remote sensing, geographic information system (GIS), and other technologies regarding this. As an example, with regard to a small island developing state, i.e., the Dominican Republic, which is vulnerable to natural disasters like hurricanes, earthquakes, etc., SDI helps in sharing information, while emergency mapping operations (EMOs) assist in decision-making. The evaluation of future outlines for SDI implementation to reach emergency mapping objectives needs the consideration of a broad range of stakeholders with contrasting objectives. In the reference study, multi-actor multi-criteria analysis (MAMCA) introduced a road map to collaboration between different parties who were all devoted to implementing an SDI that offers a framework for EMOs during emergency conditions (Rosario Michel and Gonzalez-Campos, 2023) [20].

#### *2.5. Comparative Methods of Geoportal Functionality Are Used for Research*

Soldatke et al. (2023) [21] in their study explained the differences in the spatial evolution of seaside towns in the course of as well as outside the summer season according to the illustration of the Polish towns of Puck and Wladyslawowo. They also examined as well as assessed the tourist services which have been offered in those towns, developing permanent solutions, providing tourism seasonality, the implementation of spatial tools, local residents' points of view on tourist traffic, the development of resorts for tourists, and the many developments regarding the spatial development projects in those particular towns.

#### *2.6. An Important Element for Sustainable Development Is the Introduction of Protective Rights of Land, Infrastructure above, in, and below the Ground, and Special Markings on Maps and ISO Standards*

Developing an infrastructure is an essential criterion and the development of a geospatial data infrastructure has been introduced to collaborate and exchange information at the national level as well as simultaneously develop the INSPIRE geoportal of the European Commission's Community Research Center. In using these, they have found novel challenges as well as opportunities to solve the problems. The study conducted by Ogryzek et al. (2019) [22] showed that there is a possibility of the evolution of maps which indicate utility networks as well as the rights for land which is obtained by utility companies. The information regarding remote sensing methods is helpful for the exposure of rights on maps of a technical framework, as at present, there are no details available in the systems. The progressed result can be used by both local as well as national geoportals.

#### *2.7. There Have Been a Number of Initiatives across Europe to Improve Spatial Data Infrastructures Run by Both Public and Private Administrations*

The British are acknowledged as the leading experts on spatial data infrastructure and the lately released book which is reviewed by GIS professionals on creating spatial data infrastructure. In this book, there are four chapters. In the first chapter, the authors explain the uses of GIS, which focuses on their application as well as AGI role in outreaching work. In the second chapter, they explain how it works prior to introducing SDIs and what they actually are along with why they are necessary. In the third chapter, the authors discuss the available SDIs in Europe which can be seen in the Czech Republic, Germany, Finland, France, Northern Ireland, and Lithuania. The fourth chapter describes the most practical

implications regarding this and promises advantages up to 10 times the cost (Masser and Crompvoets, 2007) [23].

### *2.8. Research Gap*

In light of the findings of the current literature analysis, it is crucial to explore the sustainable adoption of innovative digital technologies in DT. A questionnaire survey approach was used in the study to obtain the primary information from respondents. Research indicates that the sustainable adoption in DT projects benefits from effective governance by enhancing stakeholder engagement, resource allocation, and risk mitigation for successful implementation and outcomes. From the previous research, it was found that there is no explanation in detail about the combination of digital transformation and sustainability principles. The role of innovative digital technologies in promoting business organizations has not been elaborated on in previous studies; it is unclear from the research how to achieve sustainability goals in DT initiatives. There is no clear explanation of the correlation between digital technologies in DT. The innovation of digital technologies appears to have a significant influence on the long-term sustainability outcomes for organizations, although this is not well explained. Therefore, the objective of this study is to explore the importance of the sustainable adoption of innovative digital technologies in DT.

## **3. Theoretical Framework**

The theoretical framework discusses the efficiency of the transformation, long-term sustainability outcomes for organizations, competitive advantage, governance, and management: stakeholder engagement, resource allocation, risk mitigation, resources and support for successful implementation, and sustainability goals in digital transformation initiatives.

### *3.1. The Efficiency of the Transformation*

DT is the process of integrating digital technologies into various aspects of a business, leading to significant changes in its operations, strategies, and overall value proposition [1]. DT improves operational efficiency by automating manual processes and streamlining workflows. By implementing digital tools and technologies, organizations can eliminate repetitive and time-consuming tasks, reduce human errors, and increase productivity. This allows employees to focus on more strategic and value-added activities, ultimately leading to improved performance across the team. DT improves communication and collaboration within and outside the organization [24]. By adopting digital platforms such as project management tools, instant messaging, and video conferencing, teams can collaborate in real time regardless of their location. DT enables organizations to implement data analytics and business intelligence tools through which organizations can gain valuable insights into customer behavior, market trends, and operational performance [25]. By leveraging these insights, companies can make data-driven decisions, improve their strategies, and identify areas for improvement, thereby improving performance and staying competitive in the digital age [26].

### *3.2. Long-Term Sustainability Outcomes for Organizations*

DT can improve operational efficiency, improve customer experiences, and drive innovation, while also having significant long-term sustainability consequences for organizations [27]. DT helps companies reduce their environmental footprint. By leveraging digital technologies, organizations can streamline processes, automate tasks, and reduce the need for physical resources. This leads to reduced energy consumption, reduced carbon emissions, and reduced waste generation [28]. DT develops a culture of innovation and agility within organizations. DT promotes collaboration and knowledge sharing within organizations and across supply chains. By implementing collaborative digital platforms and communication tools, companies can reduce the need for physical travel, leading to reduced transportation-related emissions [29]. DT enables organizations to engage with stakeholders and customers in more sustainable ways. Through digital channels,

companies can communicate their sustainability efforts, promote eco-friendly products and services, and educate consumers about responsible consumption [30]. This will lead to increased customer loyalty, brand reputation, and ultimately a more sustainable business environment.

### *3.3. Competitive Advantage*

DT involves leveraging emerging technologies such as artificial intelligence, machine learning, cloud computing, big data analytics, and the Internet of Things (IoT) to drive innovation, streamline operations, and deliver enhanced value to customers [31]. The benefit of DT lies in the ability to collect, analyze, and leverage vast amounts of data to derive actionable insights. Advanced analytics and data-driven decision-making can help organizations improve their operations, personalize customer experiences, and identify new growth opportunities. Also, DT helps organizations improve their agility and responsiveness to changing market dynamics. The adoption of digital platforms and automation helps companies improve efficiency, reduce costs, speed up the time to market, and adapt quickly to customer needs [32]. By leveraging digital channels, personalized marketing strategies, and omnichannel capabilities, companies can engage with customers across multiple touchpoints, address their needs, and deliver tailored solutions, building loyalty and differentiation in the marketplace. A competitive advantage in DT is achieved by aligning technology investments with strategic objectives, continuously innovating and adapting to digital trends, and encouraging a culture of digital agility and customer centricity [33].

### *3.4. Governance and Management: Stakeholder Engagement, Resource Allocation, and Risk Mitigation*

Governance and management play a vital role in ensuring the success of DT [34]. Stakeholder engagement involves the active involvement and participation of stakeholders throughout the transformation journey. This includes employees, customers, suppliers, and other related parties. Engaging stakeholders allows organizations to gather valuable insights, address concerns, and create a shared vision for change. Resource allocation is another important component of administration and management [35]. DT often requires significant investments in technology infrastructure, talent acquisition, training, and process redesign. Effective resource allocation involves identifying and prioritizing the resources needed for successful change, ensuring their availability and appropriate use. Risk mitigation is an integral part of governance in DT. This process involves identifying potential risks and developing strategies to minimize their impact. Risks include technical challenges, security threats, resistance to change, and regulatory compliance issues. Through proactive risk assessment and mitigation planning, organizations can anticipate and address potential obstacles, ensuring a smooth transition process. Governance and management of DT require active stakeholder engagement, strategic resource allocation, and robust risk mitigation strategies [36]. By adopting a comprehensive approach to these areas, organizations can increase their chances of achieving successful DT outcomes.

### *3.5. Resources and Support for Successful Implementation*

A successful DT requires careful planning, execution, and ongoing support. Building a team of individuals with diverse skills and expertise in areas such as technology, project management, change management, and data analytics will play a key role in driving DT [37]. Engaging experienced consultants specializing in DT to provide guidance, best practices, and strategic insights will help assess the current state, define a roadmap for change, and provide support throughout the implementation process [38]. The implementation of collaboration tools and platforms facilitates communication and knowledge sharing among employees. Collaborating with technology vendors and partners who can provide technical expertise, support, and innovative solutions will also help ensure access to the latest advances in technology [39]. By adopting resources and support mechanisms,

organizations can increase the likelihood of successful DT, business growth, improved efficiency, and improved customer experiences [40].

### 3.6. Sustainability Goals in Digital Transformation Initiatives

Considering sustainability in digital strategies can help organizations achieve multiple objectives. DT initiatives can enable energy efficiency and resource optimization [41]. Using digital tools and technologies can help businesses streamline processes, reduce paper usage, reduce waste, and improve energy consumption. This leads to less environmental impact and cost savings. Sustainable DT efforts prioritize the use of renewable energy sources. Adopting cloud computing, virtualization, and data centers powered by renewable energy also reduces greenhouse gas emissions [42]. DT will encourage a shift toward remote work and virtual collaboration, reducing travel-related carbon emissions and supporting a more sustainable work environment [43]. Integrating sustainability goals into DT efforts empowers organizations to adopt eco-friendly practices, optimize resource use, reduce environmental impact, and contribute to a more sustainable future.

## 4. Conceptual Framework

This study investigates the significance of the long-term adoption of cutting-edge digital technologies in DT. The presented conceptual framework illustrates the key concepts related to innovative digital technologies in DT. This study formulated hypotheses H1, H2, H3, H4, H5, and H6. Figure 2 shows the conceptual framework of this study. The efficiency and productivity of the DT implementation process within an organization involves improving workflows, streamlining operations, and efficiently achieving desired outcomes. It refers to the results and impacts an organization wants to achieve through DT, which are sustainable and provide ongoing benefits beyond the initial implementation phase. The specific goals or objectives an organization sets to achieve sustainable outcomes through DT may relate to environmental sustainability, social impact, ethics, or economic development. How these key concepts interrelate and influence the context of DT and sustainability in organizations can show relationships between performance, sustainability, competitive advantage, governance and management, resources and support, technology, and sustainable goals, contributing to successful and sustainable DT efforts.

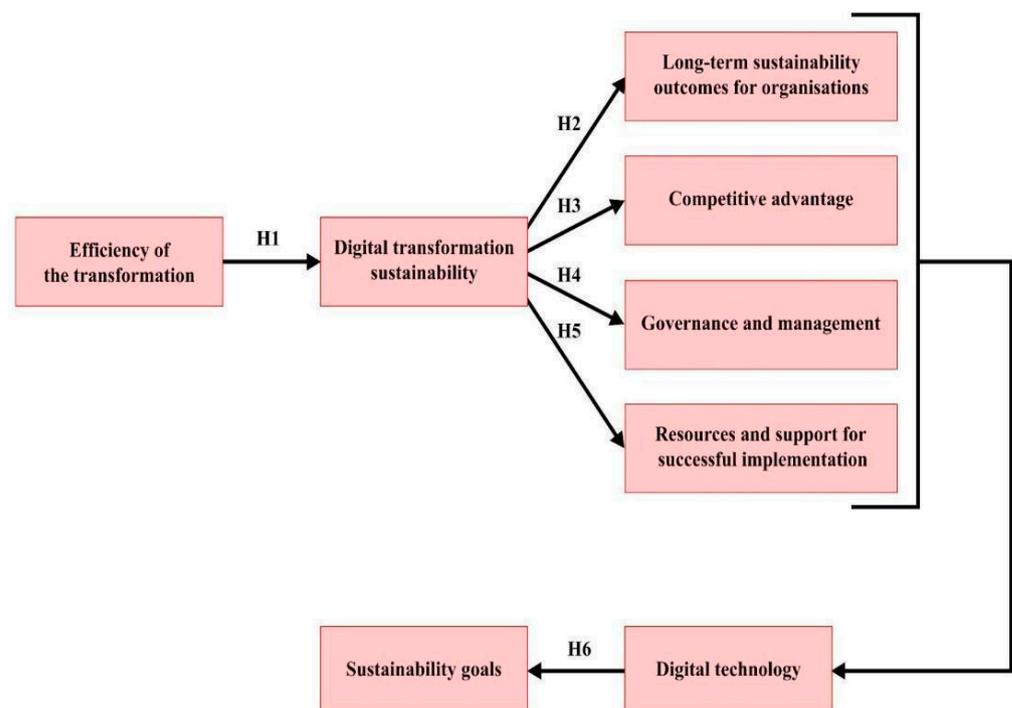


Figure 2. Conceptual framework.

#### 4.1. Digital Transformation and Sustainability Principles

Adopting digital technologies can help companies improve their operations, streamline processes, and reduce resource consumption, leading to a lower carbon footprint and improved environmental performance [44]. DT enables improved transparency and accountability, allows organizations to actively engage with stakeholders, and addresses social issues such as diversity, inclusion, and ethical practices [45]. This integrated approach promotes a more sustainable and resilient future for businesses and society as a whole.

**H1.** *The combination of digital transformation and sustainability principles positively influences the efficiency of the transformation which can be measured by environmental, social, and economic performance indicators.*

#### 4.2. Digital Transformation Goals and Long-Term Sustainability Outcomes for Organizations

Aligning DT goals with SDGs can lead to increased long-term sustainability outcomes for organizations. By integrating the SDGs into their DT strategies, organizations can contribute to these broader social goals while reaping many benefits [46]. DT can enable more efficient and sustainable operations. Technologies such as data analytics, IoT, and artificial intelligence can improve resource consumption, reduce waste, and improve overall productivity, leading to cost savings and reduced environmental impact. SDGs can improve a company's reputation and brand value, as it demonstrates a commitment to social and environmental responsibility. It will attract customers, investors, and talent who prioritize sustainability [47]. DT can enable more efficient and sustainable operations. Hence, we can state,

**H2.** *Aligning digital transformation goals with SDGs increases long-term sustainability outcomes for organizations.*

#### 4.3. Digital Technologies Have a Significant Impact on Organizations' Competitive Advantages

The digitalization of an economy is one of the most crucial elements in establishing sustainable competitive advantages for the entire economy. The distinction between business and technology functions is becoming blurrier as traditional industrial structures and business models are destroyed [48]. Technology now plays a significant role in the global economy and provides a sustained competitive edge. Today's IT startups compete for digital innovation by developing solutions that draw on and generate synergies in industries like healthcare and home automation [49]. Reusable solutions made possible by innovators allow regional teams to design and gain a competitive edge by using their goods and services [50]. The most widely used digital platforms have an impact on markets, society, and people. Creating a new economic arena and altering how operations are carried out has altered the global economy. Consumers and businesses have seen a significant economic effect as a result.

**H3.** *Digital technologies focusing on sustainability gain organizations a competitive advantage.*

#### 4.4. A Digital Transformation Plan Influences Effective Management

Governance is one of the most crucial elements in managing digital change. To prevent and lower the risk of DT, good governance is essential. There are dangers in every digitization project, but these can be minimized by using a strong approach to DT governance [51]. Due to the complicated and disruptive nature of such initiatives, stakeholder engagement is extremely important in the context of DT projects. Major adjustments to an organization's processes, technologies, and culture are frequently a part of DT [52]. The project's success depends on managing stakeholder expectations and fostering a collaborative environment. Project managers can create a common understanding of project goals, recognize and reduce potential risks, allocate resources effectively, and win the support of all pertinent parties by successfully engaging stakeholders [53]. Stakeholder involvement also makes it easier to receive ongoing feedback and make improvements, which ultimately increases the likelihood that a digital transformation will be successful.

**H4.** *Sustainable adoption in digital transformation projects benefits from effective governance by enhancing stakeholder engagement, resource allocation, and risk mitigation for successful implementation and outcomes.*

#### *4.5. Digital Transformation Has a Significant Impact on Successful Business Execution*

As sustainability becomes a growing concern for businesses and society as a whole, organizations are recognizing the need to prioritize sustainable practices. By highlighting the sustainability benefits of a DT plan, it becomes easier to gain support and resources from stakeholders who value environmental and social responsibility. A comprehensive DT can lead to significant cost savings in the long term [54]. By implementing digital solutions and automation processes, businesses can streamline operations, reduce waste, and improve resource allocation. DT efforts often result in improved efficiency, agility, and customer experience. By using technology to deliver sustainable solutions, businesses can differentiate themselves from competitors and position themselves as industry leaders in sustainability practices [55]. This will attract investors, partners, and customers who prioritize sustainable businesses, leading to increased resources and implementation support.

**H5.** *Prioritizing a comprehensive digital transformation business case with sustainability benefits and multidimensional returns increases resources and support for successful implementation.*

#### *4.6. Innovative Digital Technologies Influence Sustainability Goals in Digital Transformation Initiatives*

The use of innovative digital technologies plays an important role in achieving sustainability goals. These technologies include artificial intelligence, IoT, blockchain, cloud computing, or data analytics [56]. By developing these technologies, companies can improve resource use, reduce waste, and improve overall efficiency, thus contributing to sustainability objectives. The successful integration of digital technologies into a company's existing infrastructure is essential. This integration ensures that technologies communicate effectively with each other and with other business processes [57]. By integrating digital solutions, organizations can streamline operations, reduce redundancies, and improve their ability to effectively address sustainability challenges. Successful DT and sustainability initiatives require the engagement of various stakeholders, including employees, customers, suppliers, and communities [32]. Involving stakeholders throughout the process helps create a shared vision, encourages collaboration, and develops a sense of ownership.

**H6.** *Implementing innovative digital technologies with robust integration, change management strategies, and stakeholder involvement significantly contributes to achieving sustainability goals in digital transformation initiatives.*

Although some previous studies have supported the hypotheses proposed in this section, further empirical evidence is needed for the research to be successful. Therefore, the research used specific methods presented in the sections below to show that all the proposed hypotheses are true.

## **5. Research Methods**

This methodology section describes the methods used to carry out the suggested study. So, the methodology used in the current study is quantitative. SPSS software has been used in the study, i.e., IBM SPSS 29 version. This software is used for a reliability test, ANOVA test, as well as Chi-square test. SPSS software is used in the methods because it is helpful in performing statistical and quantitative data analysis. In the study conducted by Bao and Zhang (2023) [58], they discussed the impact of digital transformation on enterprise innovation performance under the background of information management based on SPSS statistical software. From the inspiration of that study, we have taken the SPSS software methodology to gain the desired results. Data were gathered using a primary-instrument questionnaire survey to analyze the study's purpose. The methodology used in this study,

including the research design, data collection, and processing and analysis of the data, is covered in detail in the section that follows.

### 5.1. Research Design

The study adopted a descriptive quantitative research design based on the research question, research objectives, phenomena of interest, population, and the sample of the current study. These quantitative research methods place a strong emphasis on numerical, statistical, and/or statistical analysis of data gathered through questionnaire surveys.

### 5.2. Data Collection

The data used in this study were gathered between 8 January and 17 March 2023. A questionnaire survey was conducted online among stakeholders over the age of 25 in Saudi Arabia who were sustainability practitioners, IT professionals, industry experts, ICT users, and stakeholders. A total of 760 individuals ultimately took part in the survey. In Table 1, the demographic traits are listed. Gender shows that 50.53% of respondents were male, and 49.47% of respondents were female, thus the majority of respondents were male. According to the age group, 13.95% of respondents were between the ages of 25 and 34, 59.61% were between the ages of 35 and 44, and 26.45% were over the age of 45. In terms of profession, 25.26% of the respondents were sustainability practitioners, 25.13% of the respondents were IT professionals, 24.74% of the respondents were industry experts, and 24.87% of the respondents were ICT users and stakeholders. Regarding professional experience, 23.16% of respondents had experience of 15 years or more, followed by 28.68% who had experience of 5 to 10 years, and 48.16% who had experience of 11 to 14 years.

**Table 1.** Demographic details of the respondents.

Category	Sub-Category	Frequency	Percentage
Gender	Male	384	50.53
	Female	376	49.47
Age group	25–34 years	106	13.95
	35–44 years	453	59.61
	45 years and above	201	26.45
Occupation	Sustainability Practitioners	192	25.26
	IT Professionals	191	25.13
	Industry Experts	188	24.74
	Users and Stakeholders	189	24.87
Experience	5–10 years	218	28.68
	11–14 years	366	48.16
	15 years and above	176	23.16

### 5.3. Reliability and Measurement Analysis

The current study investigates how innovative digital technologies are adopted sustainably in the context of DT. In Table 2, environmental performance, social performance, and economic performance make up the first-factor efficiency. Second, three components make up the sustainability outcomes factor: environmental sustainability, social sustainability, and economic sustainability. Third, the competitive advantage factor is made up of four components: attracting and retaining top talent, enhanced brand reputation and customer loyalty, access to new markets and business opportunities, and cost efficiency and resource optimization. Fourth, the governance and management factor is made up of three components: risk reduction, resource allocation, and stakeholder engagement. Fifth, stakeholder support, human resources, organizational leadership and sponsorship, and

financial resources make up the resources and support factor. The sixth-factor sustainability goals are made up of two components: social inclusivity and equity and ethical and responsible technology use.

**Table 2.** Measurement reliability, mean, and SD.

Factors	Variables	No. Questions	SD	Mean	Reliability
Efficiency	Environmental Performance	3	1.036	4.073	0.898
	Social Performance	2			
	Economic Performance	3			
Sustainability outcomes	Environmental Sustainability	3	1.296	2.791	0.85
	Social Sustainability	3			
	Economic Sustainability	2			
Competitive advantage	Cost Efficiency and Resource Optimization	3	1.361	3.258	0.86
	Enhanced Brand Reputation and Customer Loyalty	2			
	Access to New Markets and Business Opportunities	3			
	Attraction and Retention of Top Talent	3			
Governance and management	Stakeholder Engagement	2	1.035	3.355	0.801
	Resource Allocation	3			
	Risk Mitigation	3			
Resources and support	Stakeholder Support	3	1.307	2.217	0.932
	Human Resources	2			
	Organizational Leadership and Sponsorship	2			
	Financial Resources	3			
Sustainability goals	Social Inclusivity and Equity	3	1.808	3.607	0.908
	Ethical and Responsible Use of Technology	2			

The items were created using the items that had been used in earlier studies. For internal consistency, the items' Cronbach's alpha values were examined. In general, measurements are regarded as being accurate if their Cronbach's alpha values are 0.6 or higher. The Cronbach's alpha for every variable used in this study was higher than 0.7. Table 3 provides the results of the reliability analysis.

**Table 3.** Frequency of acceptance.

Hypotheses	Statements	Disagree	Neutral	Agree
Hypothesis 1	I have observed that digital transformation and sustainability principles enhance efficiency, resulting in improved environmental, social, and economic performance indicators.	22 2.89%	77 10.13%	661 86.97%
Hypothesis 2	I feel like aligning digital transformation goals with SDGs improves long-term sustainability outcomes, positively impacting society and the environment.	45 5.92%	85 11.18%	630 82.89%
Hypothesis 3	In my opinion, digital technologies prioritize sustainability, giving organizations a competitive advantage and contributing to a sustainable future.	30 3.95%	92 12.11%	638 83.95%

Table 3. Cont.

Hypotheses	Statements	Disagree	Neutral	Agree
Hypothesis 4	I believe that effective governance practices in digital transformation projects lead to sustainable adoption, stakeholder engagement, resource allocation, and positive outcomes.	7	161	592
		0.92	21.18%	77.89%
Hypothesis 5	I have witnessed that prioritizing a comprehensive digital transformation business case with sustainability benefits is crucial for securing resources and support.	15	54	691
		1.97%	7.11%	90.92%
Hypothesis 6	I can attest to the significant contribution made by implementing innovative digital technologies with robust integration, change management strategies, and stakeholder involvement.	60	32	668
		7.89%	4.21%	87.89%

#### 5.4. Study Area

The data for the study were collected between 8 January and 17 March 2023. The study area which was selected was Saudi Arabia, where a desert climate is observed, and very hot and dry summers can be seen. The survey was taken online with the help of Google Forms, and the respondents who took part numbered 760, including males as well as females over the age of 25 years.

## 6. Results

The study's results are presented in this section along with statistical analyses and data visualizations. This section also describes the results of the data analysis, interpretation, and evaluation that were performed throughout the research process.

### 6.1. Descriptive Analysis

To examine respondents' attitudes toward the acceptance of the sustainable adoption of innovative digital technologies in DT, a simple frequency analysis was carried out. Table 3 displays the frequency conversion reply from 5 to 3—a point scale. The six assertions had acceptance rates that were higher than 70%, showing that respondents were satisfied with the acceptance. The sustainability outcomes item (item 2) received the most consent out of the six items, while the competitive advantage item received the least. According to these findings, respondents appeared to have a more positive attitude toward sustainability outcomes that promote environmental, social, and economic sustainability. It should be noted that the rate of approval was highest in the first two of the six statements.

The frequency and mean of acceptance are shown in Table 4 in relation to each variable. ANOVA was used in this study to compare means across multiple groups of variables. Chi-square tests, on the other hand, were used to investigate the interrelation of independence between categorical variables. Table 1's frequency reveals that the majority of respondents (661) agreed that digital technologies are efficient in terms of their effects on the environment, society, and economic performance ( $p < 0.01$ ). Innovative digital technologies deliver sustainability outcomes based on their effects on environmental sustainability, social sustainability, and economic sustainability ( $p < 0.01$ ). Innovative digital technologies offer competitive advantages in terms of cost efficiency and resource optimization, improved brand reputation and customer loyalty, access to new markets and business opportunities, and attracting and retaining top talent ( $p < 0.01$ ).

Based on their results in stakeholder engagement, resource allocation, and risk reduction, innovative digital technologies enhance management and governance ( $p < 0.01$ ). In terms of their effects on stakeholder support, human resources, organizational leadership and sponsorship, and financial resources, the sustainable adoption of innovative digital technologies enhances resources and support ( $p < 0.01$ ). The sustainable adoption of innovative digital technologies in DT promotes sustainability goals based on social inclusion and equity and the ethical and responsible use of technology ( $p < 0.05$ ). The ANOVA test determined a statistically significant impact on sustainability outcomes, whereas the Chi-square test determined if there is a significant association between these variables.

According to the ANOVA test, the study found a significant difference among the groups being compared. Similarly, Chi-square tests were accomplished to examine the correlation among the categorical variables, like sustainability outcomes, cost, and business opportunities. In addition to this, the interpretation of results considered the significance level using a  $p$ -value to evaluate the practical significance of the findings. As a result, the significant ANOVA and Chi-square test results of these variables suggests that these factors significantly contribute to achieving sustainability goals, supporting the hypotheses. From the frequency of the respondents' agreement on the factors and their variables, the study demonstrates that the proposed six hypotheses are supported by the study results.

**Table 4.** Frequency and mean.

Factors	Classified	Frequency			ANOVA	Chi-Square
		Disagree	Neutral	Agree		
Efficiency	Environmental Performance	22	77	661	62.679 **	29.079
	Social Performance					
	Economic Performance					
Sustainability outcomes	Environmental Sustainability	45	85	630	40.085 **	45.283
	Social Sustainability					
	Economic Sustainability					
Competitive advantage	Cost Efficiency and Resource Optimization	30	92	638	62.502 **	43.661
	Enhanced Brand Reputation and Customer Loyalty					
	Access to New Markets and Business Opportunities					
	Attraction and Retention of Top Talent					
Governance and management	Stakeholder Engagement	7	161	592	38.617 **	20.233
	Resource Allocation					
	Risk Mitigation					
Resources and support	Stakeholder Support	15	54	691	38.667 **	10.968
	Human Resources					
	Organizational Leadership and Sponsorship					
	Financial Resources					
Sustainability goals	Social Inclusivity and Equity	60	32	668	46.399 *	16.731
	Ethical and Responsible Use of Technology					

Note:  $p$ -value < 0.05 \*,  $p$ -value < 0.01 \*\*.

## 6.2. Correlation Analysis

To identify whether there was a statistically significant relationship between the variables, a correlation analysis was performed. The variables governance and management and sustainability goals exhibit the strongest linear correlation (the highest coefficient value is 0.987). Between the variables of governance and management and sustainability outcomes, there is the least amount of linear correlation (the lowest coefficient value is 0.719), see Table 5.

Efficiency showed a significantly high positive correlation with competitive advantage ( $r = 0.914, p < 0.01$ ). Sustainability outcomes were highly correlated with sustainability goals ( $r = 0.979, p < 0.01$ ). Competitive advantage showed a high correlation with governance and management ( $r = 0.893, p < 0.01$ ). Also, there was a distinct correlation between governance and management with sustainability goals ( $r = 0.987, p < 0.01$ ) and positive correlations

between resources and support and sustainability goals ( $r = 0.982, p < 0.01$ ). All values of Pearson's correlation coefficient are statistically significant, according to the correlation analysis findings.

**Table 5.** Simple Pearson correlation.

	1	2	3	4	5	6
Efficiency	1					
Sustainability outcomes	0.755 **	1				
Competitive advantage	0.914 **	0.736 **	1			
Governance and management	0.848 *	0.719 **	0.893 **	1		
Resources and support	0.756 **	0.867 *	0.933 *	0.923 **	1	
Sustainability goals	0.889 **	0.979 **	0.75 **	0.987 **	0.982 *	1

Note:  $p$ -value  $< 0.05$  \*,  $p$ -value  $< 0.01$  \*\*.

The data were collected in an online mode with the help of Google Forms; the data were collected from 760 respondents. The sample questionnaire was collected and is mentioned in Appendix A. Similar to that, there were 50 questions asked, but we cannot show all 50 questions in the paper as the data become huge. As the study contains 760 respondents, the results will vary, and it will be a large number. The statements that are considered as hypotheses in Table 3 consist of the majority of the commonly stated responses to the questions asked. In Table 4, the factors regarding the questionnaire are explained with an ANOVA, which helps in analyzing variances across the means, and Chi-square, which is used to compare the results with the expected results.

## 7. Discussion

Digital transformation involves the collection and processing of vast amounts of data. Companies must prioritize data privacy and security to build trust with their customers and stakeholders [14]. The sustainable adoption of innovative digital technologies in DT means considering environmental, social, and ethical impacts throughout the entire life cycle of technology implementation. By prioritizing sustainability and responsible practices, companies can achieve long-term success while minimizing negative impacts on the environment and society [15]. The purpose of the current study is to examine the significance of the long-term adoption of innovative digital technologies in DT. Data were collected through an online questionnaire survey from 760 people over 25 years of age in Saudi Arabia who were sustainability practitioners, IT professionals, professionals, ICT users, and stakeholders. Based on the study results, the effectiveness of the transformation, as indicated by environmental, social, and economic performance indicators, is positively influenced by the integration of DT and sustainability principles. DT enables improved transparency and accountability, allows organizations to actively engage with stakeholders, and addresses social issues such as diversity, inclusion, and ethical practices. The research results show that the goals for digital transformation should be in line with the SDGs to improve organizations' long-term sustainability. SDGs can improve a company's reputation and brand value, as they demonstrate a commitment to social and environmental responsibility. According to this study's findings, digital innovations that emphasize sustainability give businesses a competitive edge. Technology has grown exponentially into a critical component of the global economy and a sustainable competitive advantage. The study results demonstrate effective governance improves stakeholder engagement, resource allocation, and risk mitigation for successful implementation and results, which benefits sustainable adoption in DT projects. Project managers can create a common understanding of project goals, recognize and reduce potential risks, allocate resources effectively, and win the support of all pertinent parties by successfully engaging stakeholders. The study results indicate prioritizing a thorough DT business case as a top priority will increase resources and support for a successful implementation that includes sustainability benefits and multidimensional returns. As sustainability becomes a growing concern for businesses

and society as a whole, organizations are recognizing the need to prioritize sustainable practices [16]. Based on the study results, in order to achieve sustainability objectives in DT initiatives, innovative digital technologies must be implemented along with strong integration, change management strategies, and stakeholder involvement. By developing these technologies, companies can improve resource use, reduce waste, and improve overall efficiency, thus contributing to sustainability objectives.

### *7.1. Practical Implications*

This study's findings can help participants and practitioners understand the value of the sustainable adoption of innovative digital technologies in the process of DT because it will have a lasting impact on their psychological well-being and daily lives. As a result, it is imperative to include sustainable adoption in digital technology development. In addition to this, the results show that the combination of DT and sustainability principles positively influences the efficiency of the transformation, which can be measured by environmental, social, and economic performance indicators. DT has become more efficient and effective thanks to technology; artificial intelligence (AI) and machine learning can hasten DT. DT is essential to business development and company expansion. People can learn about topics they were unfamiliar with by using digital platforms.

### *7.2. Theoretical Implications*

This work contributes to the corpus of literature. The relationship between sustainability and DT at the business level has only been briefly studied in the past, particularly in investigating the connections between financial performance, a sustainability strategy, and a digital business strategy. This study conceptualizes the efficiency of the transformation, long-term sustainability outcomes for organizations, competitive advantage, resources and support for successful implementation, and sustainability goals in digital transformation initiatives to investigate the conceptualized path. The finding of this study reveals that sustainable adoption in DT projects benefits from effective governance by enhancing stakeholder engagement, resource allocation, and risk mitigation for successful implementation and outcomes.

## **8. Conclusions**

This study examines the sustainable adoption of innovative digital technologies in digital transformations and its implications for organizations. The data were assembled from 760 stakeholders through a questionnaire survey, which was then analyzed using SPSS software. The result of the analysis indicated that the combination of DT and sustainability principles positively influences the efficiency of the transformation which can be measured by environmental, social, and economic performance indicators. The study findings demonstrated that aligning DT goals with SDGs increases long-term sustainability outcomes for organizations. The research identified that digital technologies focusing on sustainability gain organizations a competitive advantage. The analysis revealed that sustainable adoption in DT projects benefits from effective governance by enhancing stakeholder engagement, resource allocation, and risk mitigation for successful implementation and outcomes. The research result indicated that prioritizing a comprehensive digital transformation business case with sustainability benefits and multidimensional returns increases resources and support for successful implementation. The study result revealed that implementing innovative digital technologies with robust integration, change management strategies, and stakeholder involvement significantly contributes to achieving sustainability goals in DT initiatives. The study suggests the role of stakeholder engagement in driving successful DT and the need for strategic resource allocation and risk mitigation strategies.

## **9. Limitations and Future Directions**

In addition to this study's contribution, some limitations can be addressed in future research to improve outcomes. This study is primarily quantitative, which is insufficient

to empirically support its findings; therefore, future research could combine quantitative and qualitative research methods for improved research outcomes. This study elaborated on the significance of a company's DT, but it did not address the difficulties that arise during this process, such as a lack of an organizational change management strategy, a lack of knowledge, and internal resistance to change. So, future studies could concentrate on these issues.

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## Appendix A

Number	Questionnaire
1	Digital transformation along with sustainable development goals improve long-term sustainability outcomes. 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
2	Organizations are gaining an advantage as digital technologies prioritize sustainability. 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
3	The government's effective policies can lead to sustainable development. 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
4	Digital technologies improve sustainable development. 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

Number	Questionnaire
5	The benefits of sustainability are crucial for securing resources and support. 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
6	To what extent do you believe that the integration of digital transformation and sustainable development goals leads to improved long-term sustainability outcomes? 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
7	In your opinion, do organizations gain advantages from prioritizing sustainability through the use of digital technologies? 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
8	How much do you think effective government policies contribute to achieving sustainable development? 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
9	Please rate the extent to which digital technologies positively impact sustainable development. 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
10	To what degree do you believe that the benefits of sustainability are essential for securing necessary resources and support? 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

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