

The contribution of digital transformation to the achievement of Sustainable Development Goals

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Abstract ;

The present paper examines the contribution of digital transformation in the attainment of the Sustainable Development Goals (SDGs) through the lens of Information and Communication Technologies (ICTs). To this end, it draws upon a statistic method, descriptive method, and analytical method, economic reports and statistical data from 2022 and 2023. The findings indicate that Information and Communication Technologies (ICTs) exert a discernible influence on the achievement of sustainable development goals and positive outcomes in economic, social and environmental terms. Despite the obstacles inherent in implementing digital transformation in the pursuit of sustainable development goals.

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1. Introduction

Climate change, international conflicts and emerging crises have threatened the sustainability of the global environment along with its resources. These challenges have set back and derailed many of the seventeen (17) Sustainable Development goals (SDGs) established at the United Nations Conference on Environment and Sustainable Development (UNCSD) - the 2015 Climate Summit.

However, the Fourth Industrial Revolution, with Information and Communication Technologies, has brought about fundamental changes in human life, and has had various significant roles in bolstering initiatives aimed at achieving peace, justice, and equity among present and future generations.

As result, there has been an increasing global interest in the motivations driving investments in digital transformation, which is recognized as an accelerator for achieving the SDGs by 2030.

In the light of the above, the following question arises:

To what extent can digital transformation contribute to the achievement of Sustainable Development Goals?

To answer the research problem, we formulated the following hypothesis:

The extent to which digital transformation contributes to the achievement of Sustainable Development Goals is contingent upon the suitable utilization of information and communication technologies.

The study employs statistical method to collect statistics, wherein the descriptive method is utilized to delineate the variables under investigation, complemented by an analytical method to assess the results.

The importance of this study lies in the role of information and communication technologies in increasing global gross domestic product (GDP) rates, and in the global interest in digital transformation, particularly its role in achieving Sustainable Development Goals. It also examines the challenges that weaken the ability of digital transformation to achieve the SDGs.

The aim of the study is to identify the basic concepts related to digital transformation and sustainable development, to highlight the role of digital transformation in achieving the Sustainable Development Goals, and to address the main challenges that digital transformation faces in achieving the SDGs.

2. Digital Transformation and Sustainable Development: Key Concepts

The section below brings together the definition of key concepts relating to digital transformation and sustainable development.

2.1 Digital transformation:

In her speech at the Fifth United Nations Conference on the Least Developed Countries (LDC5) (2023), the Secretary-General of the International Telecommunication Union (ITU), Doreen Bogdan-Martin, stated that digital transformation is not only an opportunity, but an absolute necessity and a moral obligation. Digital transformation must be sustainable as well, she added (united nation web site, 2023).

Therefore, digital transformation is "a process that aims to make significant changes in organizations and their properties on the basis of a combination of information, computing and connectivity" (Nizar & al marchdi, 2024, p. 5) and a process that a corporate applies to integrate digital technology in all areas of a business, fundamentally changing how it delivers value to customers. Corporates adopt innovative digital technologies to make cultural and operational shifts that adapt better to changing customer demands (Amazon web service, 2024). Digital transformation brings fundamental changes in values of corporations and society, creating opportunities for improvement (feroz, Hagjung, & chiravuri, 2021, p. 2).

In the same vein, the World Bank made clear that digital technologies have transformed markets and economic opportunities. In 2022, mobile technologies and services attained an added economic value of 4,5 trillion US dollars, nearly 5% of global GDP, along with its contribution in embodying a percentage of 50% of the sustainable development goals globally, consequently creating nearly 16 millions direct jobs and 12 millions indirect (the mobile economy report 2023, 2023, pp. 6-7).

2.2 Development :

The report of the United Nations South Commission (1990) defines development as the process that allows human beings to develop their personality and self-confidence to eliminate fear and exploitation caused by political, economic and social oppression. It is a process of development and transformation based on the natural and human resources of society, with the aim of using them to meet and satisfy their needs. It is an effort of the people by the people and for the people with the main focus on the human being (south commission report, 1997, pp. 10-11).

2.3 Sustainable Development:

The report of the International Commission on Environment and Development (ICED) titled - our commun future - defines the concept as Development that meets the needs of the present without compromising the ability of future generations to meet their future needs.

It is also defined as a civilizational change that aims to improve society economically, socially and environmentally, by employing natural and human resources for the benefit of society and the environment, with the aim of achieving justice, efficiency and intergenerational equity in the distribution of wealth in economic, social and environmental terms (Remigihus, Ramanuskiene, & Martinkus, 2009, p. 28).

2.4 Cloud Computing:

(Schwertner, 2017, p. 390) Define it as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources". So it is All applications that are provided as services over the Internet, devices and systems in data centers that provide those services (Armbrust & fox, 2009, p. 4), such as the services provided by many companies through cloud computing connected to the Internet. Google for example has a private cloud that is used to deliver Google Docs and many other services to its users, including access to Gmail, DOCs, translation applications, maps, web analytics, and more. Similarly, Microsoft has a Microsoft® Office 365® online service that allows content and business intelligence tools to be moved to the cloud, and currently makes its Office applications available in the Cloud.

2.5 Artificial intelligence (AI):

Enabling machines to mimic human cognition and human knowledge, artificial intelligence (AI) is a term used to express the various uses of predictive statistical models, and among its functions are the following: neural networks, robotics, expert systems, machine learning, deep learning, functional use of data, language translation, data analysis, problem solving, and many analytical functions (Anthony, 2024, pp. 7-8).

2.6 Internet of things (IoT):

A network of physical objects (physical things) that communicates and interacts with each other via the Internet, not only limited to computers but connected to a network of devices of all types and sizes (cars, smartphones, cameras surveillance, medical devices, industrial systems, animals, humans, ...). They are all connected, interacting and exchanging information according to recognized protocols in order to achieve smart recorporate, smart positioning, security in control, personal online monitoring, online updating, process control and management.

Internet of Things is divided into three (3) sections, included: Human to human; Human to machine/things; Things /machine to machine/things.

They interact and communicate with each other via the Internet and seek to obtain large amounts of computing data to analyse and predict future events and be able to make the right decisions compatible with the requirements to form a smart world, in a sustainable manner.

Internet of things (IoT) relies on artificial intelligence (AI) and cloud computing to facilitate inter-objects communication. Internet of Things (IoT) is expected to be used in all areas of individual and collective life, as well as in corporates and governments to build smart and sustainable cities (Keyeur, Sunil, & Salazar, 2016, pp. 6122-6123).

2.7 Augmented Reality (AR):

Is a technology that adds virtual environmrnt things to humen interaction with real life (pereia, silva, pinheiro, carvalgo, & santos, 2024, p. 40). Augmented reality (AR) technology is based

on the principle of integrating both the processes of describing the work environment and the information about it, with a view to enabling the augmented reality (AR) process to visualise the reality of things more clearly and comprehensively (nassif, 2021, pp. 25-25). For instance, in the medical field, the novice doctor, when studying the human body system, needs to take an in-depth look to form a real image of the human body, an image that augmented reality (AR) applications can provide through 3D features.

2.8 Digital twin:

It is defined as a virtual replica of the components of a physical object created from data and information provided to the computer by the Internet of Things (IoT), in order to predict future and potential events of its physical counterpart.

The digital twin is a dynamic digital and virtual self-development that simulates the real state of things (machine, project, physical object, human, etc.). It is a representation of the real state of its physical twin in any circumstance, through the exchange of current and previous data. The simulation is not limited to the digital twin only, but any change can be imitated by its physical twin contrary to augmented reality (Maulshree, et al., 2021, p. 5).

2.9 Fifth Generation Mobile Communications (5G):

An extension of the mobile data service of the previous generations (1G, 2G, 3G, and 4G), it is characterised by ultra-high speed, invisibility (wireless), huge capacity for multiple users at any time and in any place without interruption, ten (10) times more capacity than the previous generation (4G), less costly and sustainable (Shruti & Upasna, 2015, pp. 1-4).

Analysis of Fifth Generation Mobile Communications (5G) indicates that it can achieve high economic results in the United States by creating approximately three (3) million new jobs, adding 500 billion US dollars to the US national gross domestic product (GDP). Fifth Generation Mobile Communications (5G) technologies are expected to generate 12.3 trillion US dollars in sales for various industries, and reduce unemployment by creating approximately 22 million new jobs by 2035 (Jill & Devine, 2019, p. 3).

On the other hand, [Allied Market Research predicts that the Fifth Generation Mobile Communications \(5G\)](#) and Internet of Things (IoT) markets will reach 797.8 billion US dollars by 2030, a growth rate of more than 65.80% according to the Compound Annual Growth Rate (CAGR) between 2021-2030.

3. The contribution of digital transformation to the achievement of Sustainable Development Goals

In its Digital Strategy 2022-2025, The United Nations Development Programme (UNDP) called for the transition to an ever-evolving digital reality, making digital transformation an enabler to accelerating the pace of achieving the United Nations' sustainable development agenda - the 2030 Agenda for Sustainable Development - and to reimagining development in the digital age.

United Nations Development Programme (UNDP) noted that the up coming years will be crucial in determining how digital technology can play a positive role in development, prevent economic and social harm, and mitigate emerging digital challenges and risks (Digital strategy 2022-2025, 2022, pp. 6-7).

Figure 1: Sustainable Development Goals



Source : <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

The present section aims to delineate the manner in which digital transformation contributes to the realization of several of the Sustainable Development Goals.

Goal 1: End poverty in all its forms everywhere

According to the [Secretary-General of the United Nations Economic and Social Council](#), 575 million people, about 7 % of the world's population, will still be living in extreme poverty by 2030.

On the other hand, according to the latest statistics for 2023, 5.4 billion people in the world are subscribed to phone services, representing 68 % of the world's population, and the number of subscribers is expected to reach 6.3 billion people, or 73%, by 2030. While the number of Internet users in 2022 reached 4.4 billion people, it is expected to reach 5.5 billion people by 2030, an estimated increase of 4.5 % by Compound Annual Growth Rate (CAGR) between 2022-2030. Smartphone ownership reached 76 % of the world's population in 2022 and is expected to reach 92 % by 2030.

Therefore, information and communication technologies (ICTs) enable a large part of the world's population, in different continents, to access digital platforms and websites to learn about the opportunities and services available in the digital space, so that they can choose the most appropriate, according to the available features and capabilities, in order to help them lift themselves out of poverty (the mobile economy report 2023, 2023, p. 6).

Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

Whereas smart technology in agriculture can provide tremendous potential to meet food needs, double production, reduce costs, and ensure efficiency and sustainability in food supply chains, 783 million people, nearly 10 % of the world's population, suffer from hunger (Hannah, 2024)

Among the most important technologies used in agriculture is the Internet of Things, which is used to collect data about farmland, natural objects, sunlight, temperature, humidity, and the safety of stored objects. Likewise, artificial intelligence and robots assist in planting, digging and various related operations, while advanced data analysis systems provide the ability to anticipate and predict climate changes and the damage they can cause to agricultural products. Global Positioning System (GPS) and drones help identify exploitable farmland in order to maximize productive surfaces, along with other digital technologies that positively affect the sustainability of farming. These will contribute to guarantee food abundance, thus

ending famine (Read, 2023). And more, artificial intelligence (AI) techniques such as random forest, fuzzy logic, robotics, neural network have exhibited the possibility of achieving for objective that enhancing the farmers lifehood, minimizing food prouduction cost, controlling food price fluctuation and ensuring food choices to consumers (Vilani & Subgagini, 2023, p. 55).

Goal 3 - Ensure healthy lives and promote well-being for all at all ages

During the COVID-19 pandemic, new methods of treatment and care were disseminated, to which information and communication technologies (ICTs) made a significant contribution, such as telemedicine, which has been widely adopted by various public and private health care users for the benefits it brings to the treatment process despite the distance. It reduces costs and travel for patients and offers greater convenience, especially when using videoconferencing technology that allows the doctor to monitor the patient remotely. Social media has contributed to patient interaction with hospitals and doctors, and the ability to make appointments free of charge and transparently, which has helped promote good health and well-being (Devesh & pal, 2023, pp. 1169-1170)

Goal 4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

In the digital age, the image of education has changed and the learning environment has been digitized thanks to smart technologies that provide learners with flexible and effective methods and age-appropriate educational content. Smart technologies, such as augmented reality (AR), virtual reality, 3D printing, digital learning platforms such as Moodle, chatbots, ChatGPT, Google Scholar and other digital technologies, have contributed to building modern digital education models that have changed the vision of governments for their education policies in order to keep pace with technological developments and fill the emerging digital education gaps (Qingqing, Syafila, saiful, & Xin, 2024, p. 162).

Goal 5 - Achieve gender equality and empower all women and girls

Information and Communication Technologies (ICTs) provide women and girls with multiple channels to communicate with their families and work environment, and facilitate their access to the necessary information and knowledge they need at different stages of their lives, such as information on motherhood, child rearing, education, work, etc. This enables them to easily access various services available online in different areas such as health, financial services, education and transport, which contribute to the empowerment of women in society and the promotion of their rights.

In this regard, UNESCO has dedicated a programme to empower women through mobile phones connected to the Internet. The programme comprises educational content intended for women and girls to manage their personal lives, gaining confidence and knowledge on their rights, and how to set objectives. This program depicts one of the images of promoting gender parity (UNESCO, 2015, pp. 102-13)

Goal 6: Ensure availability and sustainable management of water and sanitation for all

According to the Latest statistics, around 2 billion people lack access to clean water, and approximately 5.4 billion people globally do not have access to hygiene management services .

In this context, ad hoc solutions and geographic information system (GIS) technologies can contribute to identify underground water basins to solve water shortages and water scarcity issues in deserts (Oksen & favre, 2020, pp. 4-6)

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all

The Internet of Things (IoT) and the fifth generation mobile communications (5G) are contributing to facilitated access to clean energy and technology. The latest statistics show

that the contribution of the smart lighting market in 2022 was estimated at 15.05 billion US dollars and 17.86 billion US dollars in 2023. It is expected to contribute a global share of 22.1% in Compound Annual Growth Rate (CAGR) from 2023 to 2030.

Europe will dominate the smart lighting market, and take the lead in developing safety and uniform performance standards. Asia pacific and north America are also expected to grow the fastest during the forecast period, as shown in figure 2 below:

Figure 2: smart lighting market 2023-2030



Source: Grand view Research. (2024). Smart Lighting Market Size, Share & Trends Analysis. <https://www.grandviewresearch.com/industry-analysis/global-smart-lighting-market>. (consulted on 01/09/2024).

These statistics encourage the use of technological techniques in generating sustainable and modern energy for all.

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all

In 2022, mobile technology contributed 5.2 trillion US dollars (5%) in Economic Value Added (EVA) to Global Gross Domestic Product (GGDP), and is expected to reach 5.6 trillion US dollars in 2025 and nearly 6 trillion US dollars in 2030.

Mobile industry employs approximately 28 million people worldwide, including 16 million direct jobs and 12 million indirect. Its contribution to the global tax system will reach 530 billion US dollars in 2022, of which 160 billion US dollars will be in the form of labor taxes, annual contributions and social security. Fifth Generation Mobile Communications (5G) is expected to contribute 1 trillion US dollars to the global economy by 2025 (the mobile economy report 2023, 2023, pp. 11-23).

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

By 2030, the Fifth Generation Mobile Communications (5G) is expected to contribute to building resilient infrastructures, promoting inclusive and sustainable industrialization, and fostering innovation by improving infrastructure and modernizing industries to make them sustainable, while increasing resources efficiency, and progressively adopting cleaner and greener technologies and industrial processes.

The Fifth Generation Mobile Communications (5G) is expected to contribute 46% to the service sector (such as public administration, health, education and finance), 33% to the manufacturing, in particular manufacturing technologies that will contribute to innovation

and creativity. The emergence of smart factories, smart cities, smart water and electricity networks and other smart technical systems to reduce energy waste, in addition to contributing to fuels, agriculture, e-commerce and other industrial sectors (the mobile economy report 2023, 2023, p. 24).

Goal 12: Ensure sustainable consumption and production patterns

In 2022, the size of global smart waste management market was estimated at 3.52 billion US dollars by 2024, and is projected to reach 3.91 billion US dollars in 2025 and 9.01 billion US dollars by 2033, with a growth rate of approximately 11% in Compound Annual Growth Rate (CAGR) during the period 2025-2033.

Data analytics systems and Industrial Internet of Things (IIoT) will play a prominent role in enhancing smart waste management through smart sensor technologies, strengthening the case for the adoption of smart waste management at the level of major cities and smart cities. The Internet of Things (IoT) can contribute in several ways to enhance the capacity and resilience of smart cities and help them run smartly and sustainably (Straits Research, 2024)

Air pollution monitoring devices can help reduce carbon dioxide (CO₂) emissions, smart grids, wind and solar energy generation devices, and greenhouse technologies can help maintain a favorable climate balance to increase the productivity and quality of vegetables and fruits.

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

In this context, there are very useful technologies that have a tangible contribution to the achievement of this goal, such as:

- **Cameras to monitor whale migration:** Which helps to collect data about whale night and day, to understand whale behavior and migration patterns.
- **Drones that sail and surf in pursuit of ocean:** helps forecasting hurricane intensity, detecting oil spills, conserve threatened species, informing sustainable fisheries management, mapping the seafloor (National oceanic and atmospheric administration, 2024)
- **High frequency (HF) radar data:** is used in Japan to give information, on JAMSTEC website, for fishers about the sea state and the small pacific Bluefin tuna (less than 30 KG) caught by setnet, and prepare them for releasing the young tunas according to an electronic alert. This reduces the number of days with no catch, which would reduce fuel wastage, avoid extreme over-catch to prevent price falls, and protect juveniles to increase cost-effectiveness (Jim, abbott, sakaguchi, & and others, 2020, p. 19)

Goal 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

The objective of the Global Partnership is to enhance the efficacy of monitoring procedures, thereby facilitating more optimal decision-making processes. The partnership

between UNICEF and Ericsson Inc. represents one of the most significant instances of knowledge and technology transfer in the field, yielding the creation of the website <https://maps.giga.global/map>. The website contains a map of schools connected globally, which illustrates the number of internet-connected schools worldwide and the extent of student access to the Internet, providing insight into the global landscape of digital education opportunities. Furthermore, it allows data provision and exchange to determine the extent to which children benefit from the internet services to enhance their skills and develop their knowledge.

Correspondingly, the Global Partnership for Financial Inclusion (GPFI) of the G20 countries intends to ensure financial inclusion, through benefitting women and youth, small and medium enterprises with various worldwide financial services. Supporting productivity, achieving sustainable development goals, and financial inclusion are seen as an effective mechanism to attain innovation through digital finance, subsequently promoting the global economy (Financial inclusion action plan 2023, 2023, pp. 4-17).

4. The challenges that undermine the ability of digital transformation to achieve sustainable development goals

The last present section aims to identify and examine the main obstacles that hinder the ability of digital transformation to support the pursuit of sustainable development goals.

4.1 Cybersecurity risks:

Security concerns are a significant barrier to the adoption of digital transformation, with adverse implications for sustainable development goals. The confidentiality and integrity of data and information, considered fundamental assets for societies, are increasingly threatened by breaches and cybercrimes. The vulnerability resulting from privacy violations leaves stakeholders exposed to potential abuses of their personal data. Specialized parties with an international reach perpetrate criminal activities such as theft, fraud and defrauding by exploiting fictitious virtual sites (Sodfa, 2022, p. 11), which can have a detrimental impact on the economic resilience and social stability, particularly in the context of serving Sustainable Development Goals (SDGs).

4.2 Financial and legal constraints:

A significant number of corporations are accelerating the implementation of digital transformation in order to meet the needs of their stakeholders, which in turn have prompted them to seek the integration of digital technology. Nevertheless, their financial capabilities do not allow them to achieve this objective in the near future.

Subsequently, they must concentrate their efforts on the long term, in accordance with their financial capabilities, with a view to developing an infrastructure capable of withstanding the digital business environment and addressing the various emerging digital threats (Eastgate software, 2024).

4.3 Technology infrastructure and vision deficiency:

The sustained investment of corporations in digital transformation necessitates the capacity to monitor and evaluate the development and performance of digital technologies in order to achieve favorable outcomes. This entails the ownership of cutting-edge digital technology aligned with the needs of emerging generations and the ability to utilize it effectively.

Nevertheless, a considerable number of corporations lack the capacity to analyze data and establish performance benchmarks, as well as to discern their strengths and weaknesses and assess their degree of success in achieving the objectives set out for digital transformation. This is largely attributable to deficiencies in infrastructure, along with the inability to keep pace with the evolving digital transformation process, particularly in less developed and developing countries, including those experiencing internal conflicts and external occupation (Sodfa, 2022).

4.4 Absence of strategy and culture of change:

The concept of digital transformation is more than just relying on digital technology. It is about adopting a strategic approach and formulating pertinent inquiries. What are the desired outcomes of the digital transformation process? The question arises as to how this can be achieved and who can provide assistance. Some research indicates that approximately 70% of digital transformation processes ultimately failed due to employee resistance to change. Conversely, 16% of employees reported that their respective corporates improved their performance and became sustainable in the long term because of digital transformation (Krunoslav, 2022)

4.5 The digital divide:

In 2022, according to statistics related to information and communication technology (ICT), approximately 5.4 billion people (68% of the global population) use a mobile phone, of whom 55% have access to internet. It is estimated that approximately 73% of the global population will use a mobile phone by 2030, with 64% of these individuals utilizing the internet service. The remaining percentage of the population who do not use mobile internet are expected to be primarily located in developing countries.

Additionally, it is projected that 4G telecommunications services will be utilized by approximately 36% of the global population by 2030. and 64% of the global population will have access to mobile internet, while 5G penetration is projected to reach 54% of the global population by 2030. This suggests that the dissemination of digital technology still requires further efforts and collaborations to achieve a more balanced and equitable distribution across all regions of the world, ensuring the benefits are accessible to all (the mobile economy report 2023, 2023, p. 6).

5. Conclusion:

In recent years, digital transformation has played a crucial role in accelerating the achievement of sustainable development goals around the world. And is expected to have a positive economic, social and environmental impact by 2030. In this paper, we examined the contribution of digital transformation to the Sustainable Development Goals (SDGs) through information and communication technologies (ICTs). Based on descriptive, statistics and analytical methods, as well as Current statistics and perspectives, we prove the hypothesis according to these results:

- Digital transformation has achieved significant results through its techniques facilitating all aspects of human life and helping to address deficiencies that threaten the sustainability of the global environment and its resources.
- The appropriate use of Information and Communication Technologies (ICTs) plays a critical role in the achievement of sustainable development goals. according to the statistical evidence and expectations of the 2030 Agenda for Sustainable Development.
- Digital transformation faces Multidimensional challenges that weaken its ability to achieve sustainable development goals.

To this end, we recommend:

- Intensifying cooperation between countries, especially with the developing countries, to ensure the transfer of information and communication technologies.
- Ensure the contribution of digital transformation to the achievement of sustainable development goals by incorporating digital transformation strategies (DTS) into the process.
- Raise awareness of the benefits of digital transformation and its critical role in achieving the Sustainable Development Goals.

The above recommendations have been formulated to support digital transformation in the service of the Sustainable Development Goals (SDGs), and to overcome the challenges it faces in achieving sustainable development Goals. Furthermore, this will provide a foundation for subsequent research endeavors.

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