Algeria's Sustainable Development Challenges in the Light of Digital Transformation

GRINAT Mohammed *

laboratory of the future of the Algerian economy outside hydrocarbons

M'hamed Bougara Boumerdes University, Algeria

m.grinat@univ-boumerdes.dz

Kebaili Hayet

laboratory of the future of the Algerian economy outside hydrocarbons,

M'hamed Bougara Boumerdes University,, Algeria

h.kebaili@univ-boumerdes.dz

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Abstract:

This paper explores the challenges Algeria faces in achieving sustainable development in the context of digital transformation, With the progress, in information and communication technology (ICT) nowadays the shift, to transformation is crucial for various industries to enhance effectiveness deliver top notch service quality and ensure transparency. Algeria's journey involves addressing critical obstacles, including infrastructure readiness, digital governance, and the integration of ICT in key areas such as economic growth and environmental sustainability. The paper outlines how digital initiatives-such as electronic authentication and the development of technological parks-can support sustainable development goals. However, challenges remain in ensuring equitable access, building digital literacy, and optimizing resources. Through an analysis of Algeria's approaches, to initiatives. How they influence sustainable progress in the country. This research offers suggestions to enhance the coordination, between advancements and Alegrias environmental conservation efforts well as societal and economic objectives

Keywords: Sustainable development; Digital transformation Algeria; Information and communication technology (ICT) ; Digital governance.

Jel Classification Codes:Q01, G30.

* Correspondingauthor.

1. Introduction:

The digital revolution has fundamentally transformed how nations approach sustainable development, creating both unprecedented opportunities and complex challenges for developing economies. (Messner &Nakicenovic, 2019), In years digital technologies have played a role, in supporting sustainable development objectives by providing creative solutions for economic progress as well, as social and environmental welfare, with (Alojail& Khan, 2023) highlighting how digital initiatives can accelerate progress toward sustainability targets while requiring careful consideration of resource allocation and societal impacts.

When it comes to Algeria's situation embracing change is seen as a priority and a major hurdle. Recent research by (ARRIBI & BOUTARFA, 2024) reveals that Algeria's digitization efforts face multiple hurdles, including infrastructure limitations, digital literacy gaps, and the need for comprehensive policy frameworks. These challenges are particularly evident in the post-pandemic era, where (Ben Said & Redif, 2022) The COVID□19 pandemic has sped up the need, for transformation. Highlighted significant shortcomings in digital preparedness, across different industries.

The integration of programs, in Algeria has yielded differing levels of achievement, in industries with the healthcare field being one of them, (Lahchem& Kaci, 2020) document how telemedicine and ICT integration have begun to reshape service delivery, though significant barriers to widespread adoption remain. Similarly, in the education sector, (Kechebur, 2017) identifies both promising developments and persistent challenges in integrating digital technologies into learning environments, particularly in engineering education.

Algerias path, toward transformation is closely tied to its goals, for development from a governance standpoint. (Dehimat&Bouardi, 2022) analyze the country's national innovation system in the digital era, highlighting the need for stronger institutional frameworks and coordinated policy actions. This is further supported by (Hoda, 2022) (Hoda et al., 2022) efforts, within Algeria provides evidence of advancements and ongoing obstacles related to the digitization of services.

The global context provides important benchmarks for Algeria's digital transformation journey. (KPMG, 2022) analysis of digital transformation in developing economies suggests that success requires a balanced approach to technology adoption, capacity building, and policy reform. This is particularly relevant in the African context, where (Korovkin, 2019) identifies common challenges and opportunities in national digital economy strategies across the continent.

A recent study conducted by (Loucilf,2023) the requirement to speed up Algeria's advancement in order to reach sustainable development targets., highlighting how digital technologies can enhance economic efficiency, improve service delivery, and promote environmental sustainability. However, this transformation requires careful consideration of local contexts, resource constraints, and social implications to ensure inclusive and sustainable outcomes.

Additionally in Algeria digitalization is viewed as a tool, for updating the sector and aiding sustainable development initiatives. This is particularly evident, in enhancing the accessibility of government services and streamlining processes. Digital transformation, therefore, is not merely a technological shift but a strategic pathway to reforming public administration, enhancing citizen engagement, and strengthening governance frameworks (HAKKOU & El ABJANI, 2023). By addressing these complex challenges through digitalization, Algeria aims to position itself as a leader in sustainable development within the region, setting a model for other developing nations.

This study examines the complex interplay between digital transformation and sustainable development in Algeria, paying attention to obstacles and possibilities while examining projects and policy structures along, with the difficulties, in implementation is the main goal of this study. to contribute to the understanding of how digital transformation can effectively support sustainable development goals in the Algerian context while addressing critical obstacles to progress.

1.1. Problematic and objective

What are the challenges facing sustainable development in Algeria in light of digital transformation?

1.2. Significance of the Study

The digital economy is already contributing to changing the lifestyles we live in, with the shift to remote work, the emergence of smart applications and e-commerce platforms, emerging innovations and increased adoption, all of which have made digital transformation an important topic for study, especially as it affects all aspects of social and economic life, so the state must keep pace with this accelerated progress in this technology.

1.3. The axes of the study: The study was divided into three axes

- Conceptual Framework for Digital Transformation and Sustainable Development
- Challenges of sustainable development in light of digital transformation
- The role of information and communication technology in sustainable development

2. Conceptual Framework for Digital Transformation and Sustainable Development

2.1. Concepts of Digital Transformation

Digital transformation is one of the most important drivers and catalysts of development, as it is imposed on countries and organizations to find and develop common ways and means to reach the best quality in the provision of services, Digital transformation is symbolized by DT or Digital transformation DX, which is the transformation of the business, that is, the praise of radical changes affecting the business model, procedures and processes, (Ikram, 2022) which is to bring about changes in how work is perceived, thought and actions of individual work and to improve the work environment by focusing on the use of information and communication technology, in addition to changes in organizational assumptions about jobs, so that it includes the philosophy of organizations, values, organizational structures and organizational arrangements that shape the behavior of individuals in accordance with the status of information and communication technology (Ikram, 2022)

We find several definitions of digital transformation, each according to his point of view:

- It is defined as how technology is used within institutions, government agencies and the private sector alike. It helps to improve operational efficiency and improve services provided to customers (Al-Haddad, 2018)
- It is also the process of companies moving to a business model that relies on digital technologies to innovate products and services and provide new channels of revenues and opportunities that increase the value of products (Omar, 2021)
- It is also known as transformation, which does not make the company use a certain set of technology, but rather means the company's ability to interact and succeed in new technologies and procedures now and in the future, including the adoption of processes that allow the company and its employees to strategically employ a new science on a continuous basis (Al-Khair, April 2023)
- In another definition, digital transformation is a comprehensive transformation process resulting from a combination of three phenomena: automation, dematerialization, and reorganization of mediation patterns. This transformation affects all internal work, activities, and processes. (Bouchama, 2023)

So digital transformation is "the integration of digital technology in all areas of work, which radically changes how we work. In addition, it is a cultural change that requires organizations to constantly challenge the current and future conditions, but with an attempt to adapt to any obstacles to this transformation. Thus, it is a revolution in practices, automation and simplification of processes, and thus it is a means of creating value."

2.2. Benefits of digital transformation

Digital transformation is an important means of improving societies and the judiciary on the manifestations of corruption in them and taking them towards progress and survival. Therefore, it is (Ashoury, 2023):

- Significantly saves cost, time and effort;
- Improves and organizes operational cost;
- Creates innovative new opportunities that are far from the old traditional ways of providing various services;
- Reaching a larger segment of the public, customers, consumers and competitors;
- Transparency in dealing;

- Creating an information society capable of dealing with technical data and keeping pace with the information age.

Digital transformation also has the characteristics of (Ghobeiri, 2020):

- Ability to adapt to a rapidly changing and diverse business environment;
- Excellence, as it is equipped with an internationally rated information technology;
- Cross-border, offering integrated services that organizations can benefit from;
- Building a network organization because of the nature of its work and its connection externally, locally and globally;
- Achieves the principle of transparency and integrity as a result of clear roles and responsibilities.

2.3. Digital Transformation Models

One of the most important models of digital transformation in organizations is (Kandeel, Under Publishing):

- **Behavioral model:** which is based on the behavioral variables when the process of transformation from a traditional organization to a modern digital organization and thus must focus here on the individual and collective aspects in addition to environmental and regulatory factors.
- **Social technical model:** This model focuses on business strategies in addition to the software necessary to activate computers and the degree of organizational and technical interaction.
- **The strategic transformation model:** It relies on building an information system as a capital asset for the organization and thus determining the position of the organization locally and globally in the sector and activity, and depends on building integrated information systems as information and communication technology is one of the pillars of the organization's competitive position.
- **Gradual Transformation Model**: Based on the financial capabilities of the organizations to shift from the paper-based model to the digital model and thus funding in stages given the size of the business and the financial position of the organizations.
- **Total Transformation Model:** It means that the organization is based on a philosophy of full digital transformation of all its activities to build a digital organization.
- **Organizational development model:** Here we mean the organic transformation of organizations by eliminating what is known as computer illiteracy and then transformation according to the degree of learning through training transformation instead of rigid mechanical solutions.
- **The ideal model:** which relies on the search for ideal solutions to transform organizers from the paper model to the digital model through the simulation and pre-testing process.

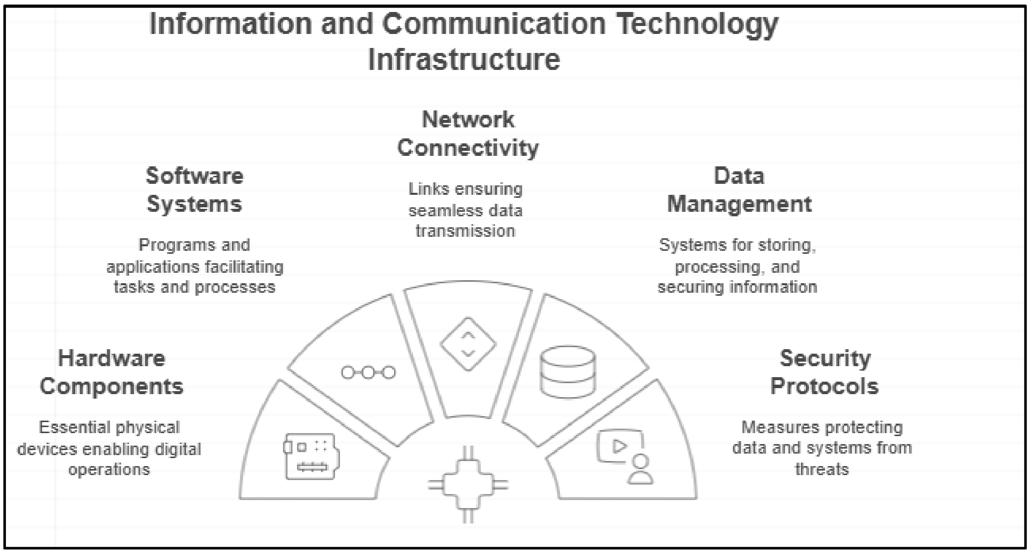
- **Cost-benefit model:** Here, the costs of switching to digital organizations are approximated by what is expected to be achieved after the acquisition of ICT, and acceptance and rejection are carried out according to the high or low costs.
- **The business model:** Some organizations rely on computer and software companies to manage the digitization process as they are pioneers in the field.

2.4. Digital Transformation Requirements

In order to implement digital transformation, many requirements must be met, which we summarize in the following four points (Albar, 2018):

- **Technologies**: Digital transformation is built using a system of devices, data, storage and software that work within technical environments and information centers that allow the use of all assets with uninterrupted operational efficiency. It also requires ensuring an appropriate level of service for the organization's individuals, customers and suppliers through professional teams responsible for managing the technical system and network infrastructure, whether this system is local or global.
- **Data**: Institutions are supposed to carry out management efforts and analyze data regularly and effectively in order to provide qualitative, documented and complete data, while providing and developing appropriate tools for statistical analysis, data research and prediction of the future. Data is also followed up in a user form to ensure that it continues to flow and benefit from it in line with the objectives and expectations of the institution
- **Human resources:** It is a vital aspect that makes it difficult for the institution to implement digital transformation without it, as it is necessary to provide qualified cadres capable of using data and analyzing it to make effective decisions. Vision planning and implementation also requires human competencies and scientific and practical experiences, with the belief that change and development of the process must establish an effective technical building that allows the development of performance internally and externally, in order to ensure the optimal application of digital transformation, including the establishment of a technical building that includes policies and procedures covering all the company's activity and operations with the necessary technologies, advanced applications and processing data

Figure 01: ICT Requirements



Source: done by Author based on: Ashouri Badreddine, Ashouri Ibrahim, The Impact of Digital Transformation on the Development of the Information and Communication Technology Sector, Journal of Finance, Investment and Sustainable Development, Volume 8, Issue 02, 2023, p.:222

3. Conceptual Framework for Sustainable Development

3.1. What is sustainable development?

Those who follow the history of development at the global and regional levels find that there has been a continuous and clear development in development as a concept and content. This development was due to the nature of the changes that have taken place and are still taking place in organizations and society. In general, we can distinguish between many stages of development of the concept of development since it was a precursor to economic growth until development included the social dimension, so it focused on addressing the problems of poverty and unemployment to renew the idea of growth and distribution to extend in the 1970s, and become the so-called idea of comprehensive development that is concerned with aspects of society and life. Its objectives are to improve living conditions (Osman Mohamed, 2nd edition, 2014)

As for the beginning of the eighties, the world began to filter on many environmental problems, which came to threaten the whole world, and this is what made international efforts intensify to make development include aspects other than the traditional aspects to become known as the sustainable world.

This concept was first crystallized in the report of the World Commission on Environment and Development entitled "Our Common Future» in 1987.

The concept of development has been associated with two types of problems (Osman Mohamed, 2nd edition, 2014):

- Widespread and increasing incidence of poverty.
- Continued degradation of the natural environment.

3.2. Origin and definition of the word sustainable development

The origin of the term sustainability goes back to ecology, where sustainability was used to express the form of the development of dynamic systems, where they are vulnerable to changes that lead to changes in their characteristics and elements and the relationship of these elements to each other.

- The definitions of sustainable development have varied, but the concept of its sustainable development was first mentioned in the report of the World Commission on Environment and Development 1987
- "Sustainable development is that development that meets the needs of the present without compromising the ability of future generations to meet their needs"
- Then came the definition of the Food and Agriculture Organization in 1989 to define it as " It is the management and protection of the natural resource base, and the direction of change, and that development, especially in the field of agriculture, forestry and fish resources, protects land, water, genetic and animal resources and does not harm the environment and is characterized as technically appropriate, economically appropriate and socially acceptable. It can also be defined as" Development that provides the needs of the present without hindering future generations from providing their social needs. (Abduljalil Ali, 2022/2023)
- As for the economic definition, it is "to alleviate the poverty situation of the world's poor by providing a secure and sustainable life, and it is determined from three resources: cultural, and social stability (Sustainable Development in the Arab World: Reality and Prospects, 1427 AH)
- A sustainable environmental definition is “development that takes into account the three main constraints that the environment imposes on the development effort, namely, the lack of wasteful use of resources. Commitment to the use of renewable resources within the limits of its ability to renew itself and the lack of the ability of the environment to digest the waste that the development effort throws at it. "

The Algerian legislator presented his definition of sustainable development in Law No.3-10 of July 19, 2003 on the protection of the environment within the framework of sustainable development (Arabic, 2019) « Reconciling social and economic development with the protection of the environment and including the environmental dimension in a development framework that includes meeting the needs of present and future generation.

3.3. Dimensions of Sustainable Developments

Many researchers believe that development has three basic dimensions (Zahra, 2023):

- **Economic dimension**: This dimension includes current and future reflections and indicators of economic activity on the environment and includes:
  - Per capita consumption of raw materials.
  - ending poverty.
  - Income distribution inequality.
- **The social dimension:** The current generations must consider the process of equity and justice in society. The social dimension is related to the individual, so its most important elements are:

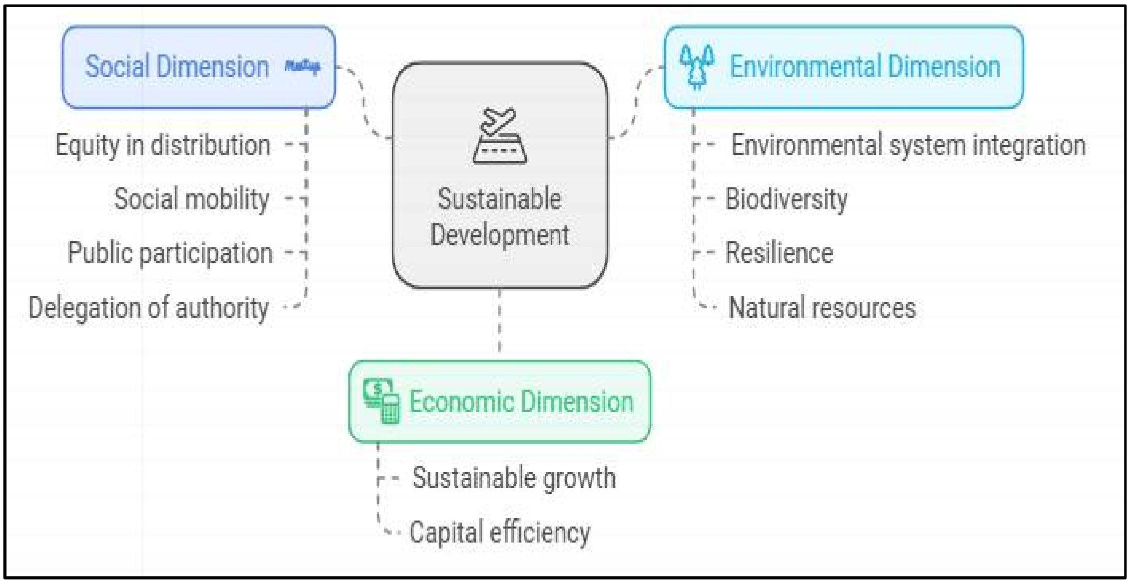
- Equality in Diversity Cultural Diversity;
- Sustainability of institutions, social mobility and popular participation.

The social dimension is that the individual is the focus of development and its ultimate goal is based on the principle of equity between individuals, nations and generations

- **Environmental dimension**: This dimension explains the strategies that must be followed in order to optimize the management of natural capital instead of wasting and depleting it in an irrational way and its most important objectives:

- Protection of natural resources and wealth
- Preserving water and protecting agricultural lands from desertification
- Protecting the climate from global warming and standing without deteriorating the ozone layer

Figure 02: Integration and overlap of sustainable development dimensions



Source: done by Author based on Othman Mohammed Ghoneim, Majed Abu Zant, Sustainable Development, its philosophy, planning methods and measurement tools, Dar Safaa for Publishing and Distribution, 2014

However, in addition to these dimensions, we find that there are secondary dimensions such as the technological, cultural and political dimension. The ecosystem is a continuous organized interaction between the living and non-living environmental elements, and the resulting balance of the interaction between the elements of the environment and the overlaps between the three dimensions in an integrated manner that cannot be separated. Each leads to the development and support of the other dimension within the framework of a political and institutional dimension that ensures continuity and communication through future time.

3.5. Economic recovery programs

During the period from 2001 to 2019, Algeria has known five basic development programs (Mohammed, 2020):

- The **EconomicRecovery Program** 2004, which had among its objectives:
  - Aggregate demand.
  - Supporting value-added productive activities and job positions by raising the level of exploitation in the agricultural sector and small and medium-sized local productive institutions.
- Preparation and completion of basic structures that allow the resurgence of economic activities;
- Human Resources Development and Poverty Alleviation;
- One of the main objectives of this program is to raise the growth rate of GDP and reduce unemployment rates.

- **The Supplementary Program to Support Growth2005-2009** is a supplementary program to support growth approved under the Supplementary Finance Law of 2005. This program aims to:

- Complete the incentive framework for investment by issuing regulatory texts that would complete the investment law and develop many measures to facilitate national or foreign private investment.
- The end of the policy of partnership promotion and privatization.

- **The five-year development program2010-2014** is considered complementary to the previous program, whether from preserving the nature of projects or the objectives of the economic sectors, one of its most important objectives:

- Fighting unemployment by targeting jobs;
- Supporting human development, that is, it is considered the main pillar of economic and social programs;
- Improving living conditions in rural areas;
- Knowledge economy;
- Improve climate, invest and maintain social peace.

− **Economic Growth Consolidation Program 2015-2019:** This program mainly aims to:

- Maintaining social gains by prioritizing the improvement of the living conditions of the population in housing, education, health, and training.
- Paying attention to economic diversification and achieving export growth.
- Creating jobs, combating unemployment and registering investment.
- In addition to the goal of raising the rate of economic growth

− **The new growth model 2016-2030:** its objectives include:

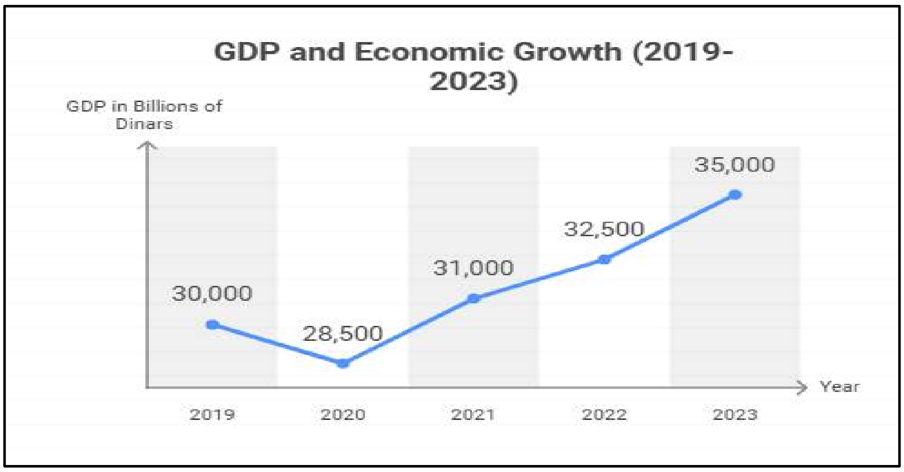
- Management and anti-bureaucracy Promotion of public-private partnership and continuing the effort towards and combating unemployment.

4. Determinants of sustainable development in Algeria

4.1. Economic Growth

Economic activity reaches its strong growth, supported by a significant recovery in the production of the extractive industry sector, with a remarkable performance in the agriculture, construction and services sectors with a growth rate of 4.1% in 2023, up from 3.6% recorded in 2022. This percentage confirms a recovery in the Algerian economy after a period of severe health crisis, recording a record growth rate between 2015 and 2023, compared to all sectors in this dynamic with significant growth, especially in the extractive industries, although many sectors recorded a significant growth rate. It should also be noted that some sectors have experienced a decline compared to their performance in 2022. (Algeria, June 2024)

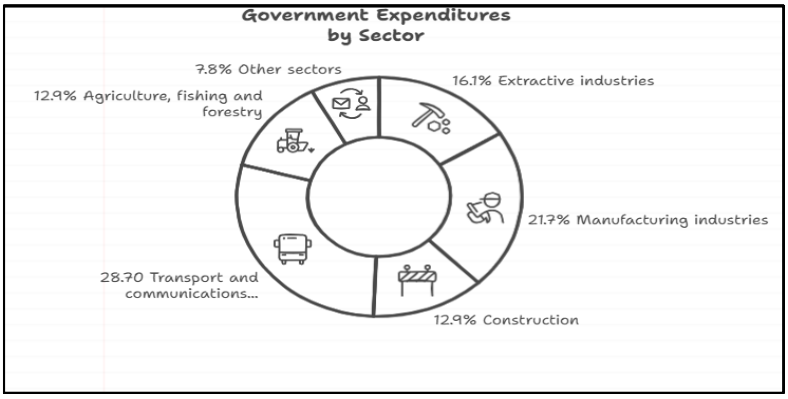
Figure 03: Growth and Development of GDP



Source: Make by authors based on: Bank of Algeria Annual Report on Monetary and Economic Development, 2023, p. 20

With regard to the analysis of the distribution of nominal GDP by various economic sectors, it is also noted that seven sectors dominate, representing a total of 80% of GDP, in descending order in terms of their share. These sectors are as follows: Extractive industries, construction, agriculture, fishing, forestry, trade, vehicle repair, household goods, transport, communications, public administration and manufacturing industries, as shown in the following figure (Algeria, June 2024):

Figure 04: The most important sectors in the GDP for 2023



Source: Make by authors based on: Bank of Algeria Annual Report on Monetary and Economic Development, 2023, p. 20

- **Unemployment:** One of the most prominent results of the economic reforms initiated by the authorities after independence is the aggravation of the unemployment problem, especially after the liquidation of institutions and the privatization process.

At the beginning of 1987, Algeria began to take many measures to reduce the problem of unemployment by (Nasser, 2010):

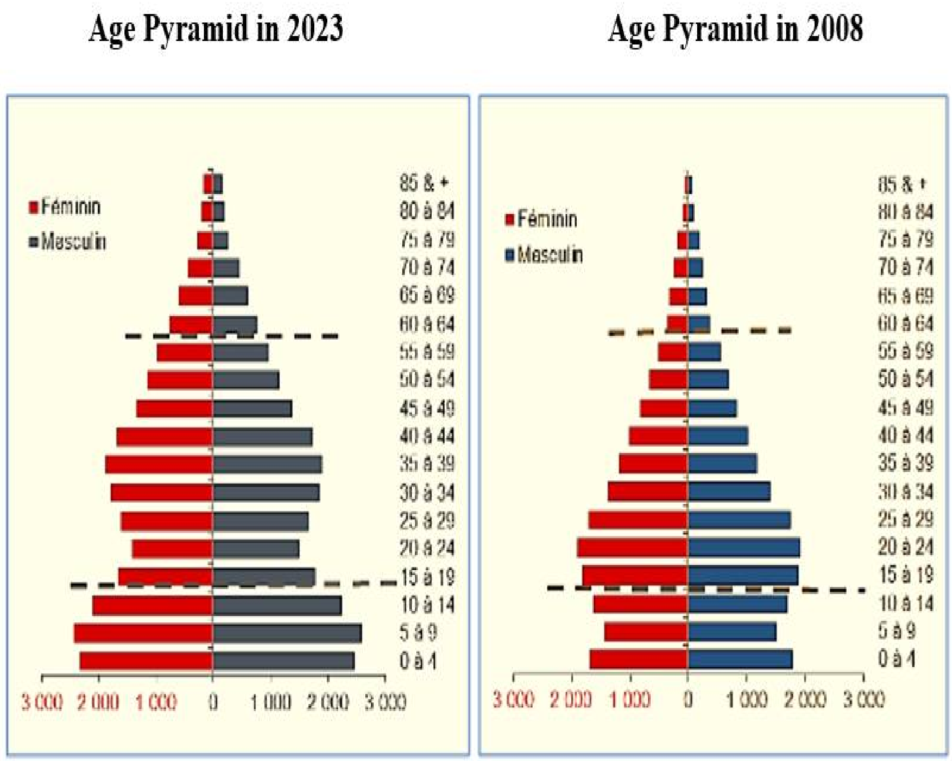
- Activities affiliated with social networks and solidarity employment (such as unemployment insurance, pre-employment contracts);
- Procedures for investment (microcredit, microenterprises,)

We note from the table that unemployment rates are in continuous decline after the high rates recorded in the past years, and this is due to the programs provided by young people in this regard by encouraging investment and the establishment of micro-enterprises and encouraging craftsmen , and a national committee for the promotion of employment was established in June 2015, which is responsible in terms of tasks for the management of the labor market for the purpose of improving the statistical and methodological media system related to the establishment of jobs and the completion of studies and evaluation of the application of the work program for the promotion of employment.

- **Poverty Index:** Algeria is characterized demographically by two main characteristics that dominate youth and rapid population growth. The proportion of young people under the age of 30 is predominant at 51% in 2023, representing 23.8 million people. The second characteristic is the rapid growth of its population, which has increased by about 12 million since 2008 to reach 43 years in 2019 and 46.5 million in 2023. This potential is largely due to an increase in the size of the first live births, which has exceeded one million since 2014. (Economic, Social and Environmental Report 2023, May 2024)

The recorded demographic changes, both in terms of structure and in terms of age, constitute a two-pronged weapon. They represent one opportunity and challenge at the same time. The following figure shows the pyramid of ages from 2008 compared to 2023.

Figure 05: Evolution of the age pyramid between 2008/2023



Source: Economic, Social and Environmental Report 2023, p. 45

A downward trend was also recorded in the proportion of the active population group and the high level of work expected at birth, as a result of improved living conditions and a decrease in the mortality rate, especially maternal mortality, in addition to the improvement in housing conditions for low-income families as a result of the introduction of many housing contexts, where the housing occupancy rate decreased significantly from 5.5% in 2000 to 4.25% in 2023. At the end of 2023, the housing stock reached 10 million and 737,112 dwellings of all types, an increase of 2.03% compared to 2022(Economic, Social and Environmental Report 2023, May 2024).

There is also continuity of population work, through new measures to improve purchasing power. There are also efforts and endeavors to improve the coverage of solidarity programs and communications, by conducting various determinants such as: improving the care of people with special needs, programs to support disadvantaged families, programs of support and social integration, and meeting special needs for the benefit of children.

4.2. Environmental Dimension

The majority of the measures taken and still being taken by the Algerian state are aimed at the rational use of natural resources, conserving them as well as protecting ecosystems in addition to trying to combat all forms of pollution and nuisance, combating desertification and climate change, as well as the integrated management of waste, andinvesting in the green and circular economy. This was shown especially after the Sustainable Development Goals Summit was held on 18 and 19 September 2023 in New York, which would have represented the beginning of a new phase of accelerated progress towards the Sustainable Development Goals. The summit also symbolizes the middle of the road towards the deadline set for achieving the goals of the 2030 program.

- The **field of waste management**: If we talk about the importance of this field, the environmental sector has recorded a lot of progress,especially in the fields of waste management, preserving reserves and combating climate change, and this is evident in the efforts to integrate sustainable development into the heart of national development policies, and directing the government's plans to work towards structural reforms to ensure a qualitative living framework that respects the requirements of sustainable development, and preserving the environment. Many initiatives have also been launched in the field of environmental transition and circular economy, especially with regard to selective sorting, developing recycling sectors and combating marine pollution. In terms of regulation, many legal texts have been amended or prepared, most notably(Majlis, 2024)

- Preliminary draft law amending and supplementing Law No. 19-1 0 of December 12, 2001 on the management, control and removal of waste.
- Preliminary draft of a law amending and supplementing Law No. 2 0- 2 0 of February 5, 2002 on the protection and development of the coastal strip
- Initiate the revision of Law 19-1 0 on the Management, Control and Removal of Waste. This approach aims to integrate the basic principle of the circular economy with the aim of reducing waste for reuse and recycling.

- **Urban pollution:** Many measures have also been taken to combat urban pollution at the national level. These measures have included a variety of aspects, including the establishment of wastewater treatment plants, the elimination of random landfills and the promotion of environmental awareness among citizens through the establishment of dedicated clubs.

Algeria has also allocated more than 100 billion Algerian dinars to invest in achieving waste management and treatment systems between 2010 and 2023

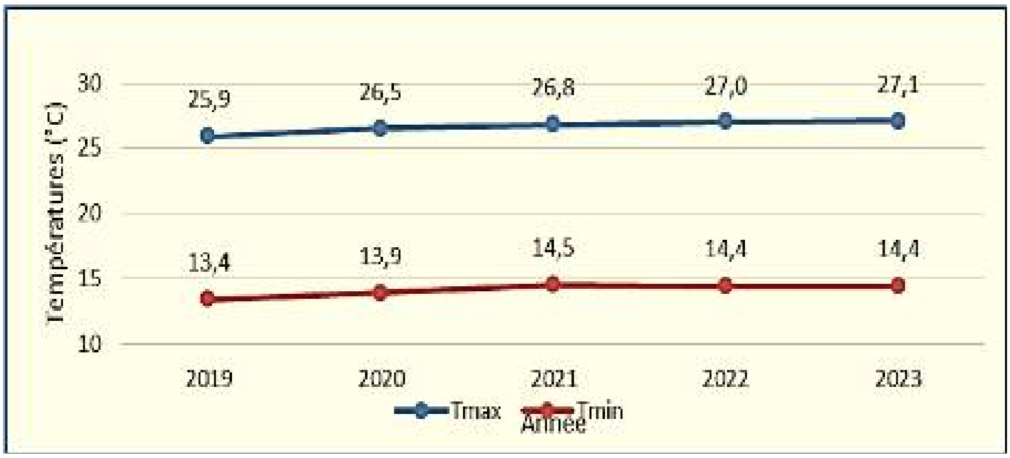
- **Atmospheric pollution and air quality:** A draft law on air pollution and air quality is expected to be prepared. Within the framework of the National Fund for the Environment and the Coast, the Ministry in charge of the Environment has included a process to studyand acquire network equipment to monitor air quality in urban areas.
- **Seas, oceans and coastal areas**(Al Hitti and Al Mohannadi, 2008)**:** Since seas and oceans constitute 70% of the Earth's area, managing these vast areas in an environmentally sustainable manner represents the greatest

challenges facing humanity. Marine and coastal issues of importance to sustainable development include the following:

- Degradation caused by land-based activities.
- Unsustainable exploitation of fish and other living resources.
- Marine pollution resulting from maritime transport and oil and gas projects in coastal waters.
- Protect biodiversity and fragile ecosystems.
- Relationship to climate change, including impacts from sea level rise.

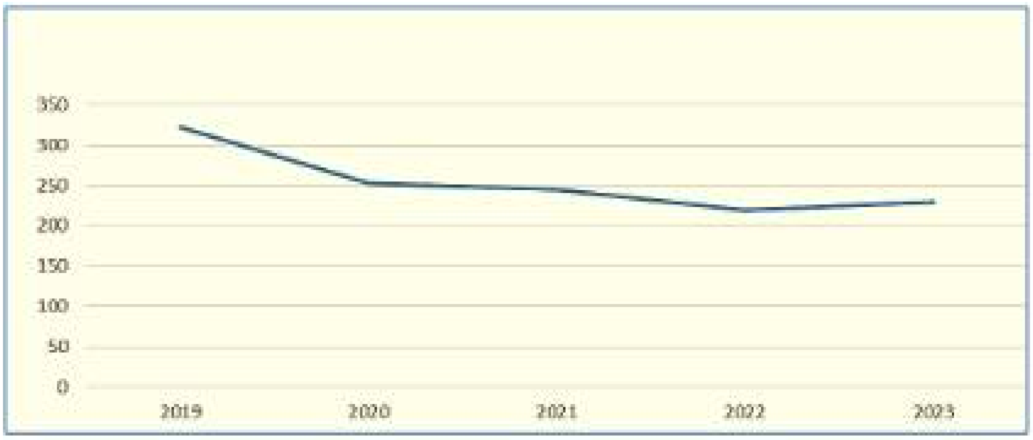
– **Combating climate change:** Algeria recorded an observed increase in average temperature at the natural rate during this period 2019 to 2023, expressed in percentage in the chart below. It also witnessed the annual rainfall in Algeria measured by the reference periods expressed by an important shift during an extended period from 2019 to 2023, as the amount of rainfall is still much lower than the natural rate recorded by the continuation of the drought phenomenon (Majlis, 2024).

Figure 06: Annual change in average maximum and minimum temperatures in Algeria



Source: Economic, Social and Environmental Report,2023, p. 61

Figure 07: Evolution of annual rainfall



Source: Economic, Social and Environmental Report,2023, p. 61

Through a table below, we will show the effects of climate change on some sensitive sectors of the national economy

Table 01: Climate change impacts in Algeria

Sectors	**Effects of Climate Change**
Agriculture	Desertification and soil erosion, decline in production and deterioration of productive resources, and their scarcity; threats to food security
Marine Fishing	Decrease in fishing resources for consumption; migration of living organisms to new regions; changes in species and depletion of resources
Construction	Deterioration of buildings, public facilities, historical landmarks, and a tendency towards migration from coastal areas due to environmental and economic activities
Energy	Increased demand for energy resources leading to overuse of fossil resources and threats to the safety of energy facilities
Industry	Decline in industrial sector performance; loss of income and job opportunities; risk to the safety of facilities
Transportation	Increase in energy consumption, exposure to higher risks associated with climate change events such as floods and heat waves
Water Resources	Decline in water resource quality, decrease in water availability, facility deterioration, and seawater leakage into coastal aquifers
Forests	Loss of forest cover and biodiversity, destruction of ecosystems, habitat loss, and forest fires due to dryness
Vegetation	Loss of green areas and arable land; destruction of biodiversity; ecosystem imbalance; soil erosion and desertification
Environment and Biodiversity	Climate change impacts fragile environments (such as wetlands and coral reefs) and threatens biodiversity, as well as altering the life cycles of plants and animals
Public Health	Direct impact on health, spread of exotic diseases northward; increased rates of infection with diseases related to water and air quality
Recurring Hazards	Increased risks of droughts, floods, heat waves, and increased frequency of storms and cyclones; rising sea levels threatening populated areas and coastal infrastructure

Source: Economic, Social and Environmental Report,2023, p. 62

In this context, Algeria has received international funding, including a $2.8 million grant from the Green Climate Fund, to prepare a national plan for adaptation to climate change. The specific objectives of this plan are to address climate challenges, especially enhancing resilience in society and the economy, enhancing the resilience of environmental systems to reduce the risk of natural disasters, rehabilitating land in accordance with the national policy to combat desertification, and integrating the impact of climate change into sectoral strategies related to water resources, agriculture, transport and health. (Majlis, 2024).

5. Challenges of sustainable development in light of digital transformation

There is no doubt that digital transformation is one of the main strategic initiatives for economic, social and cultural transformation and renewal in Algeria, and this is by helping to ensure the widespread dissemination of digital systems for this reason and in line with one of the commitments made by the President of the Republic. This process has witnessed a continuous acceleration since 2022, with the launch of the government portal for public services and the investors' platform, and the commitment is crystallized through the consolidation of institutions, this is stated in Presidential Decree No. 314-23 dated September 6, 2023 through the establishment of the Higher Authority for Digitization within the framework of a concerted approach between sectors.

In the framework of improving administrative governance, public services and the economic sector on the one hand, and on the other hand developing the social framework, it was necessary to use information and communication technology in order to reach the desired goals, especially with regard to the Millennium Goals and the sustainable development goals to 2030

Table 02: Key Pillars of Digital Transformation in Algeria

Rank	Indicator Value	Pillars	Axes
12	50.15	First Pillar: Institutions	Digital Government
8	42.33	Second Pillar: Infrastructure	Digital Foundations
9	57.86	Third Pillar: Workforce	Citizen Digital Readiness
11	51.73	Fourth Pillar: Digital Government	Digital Government
12	43.54	Fifth Pillar: Innovation	Digital Innovation
12	14.05	Sixth Pillar: Knowledge and Tech	Knowledge and Technology Use
12	28.33	Seventh Pillar: Market Strength	Digital Business
12	59.23	Eighth Pillar: Financial Market Dev	Financial Market Development
7	71.71	Ninth Pillar: Sustainable Dev	Sustainable Development
12	46.55	**Total Indicator Value**	**Overall Performance Level**

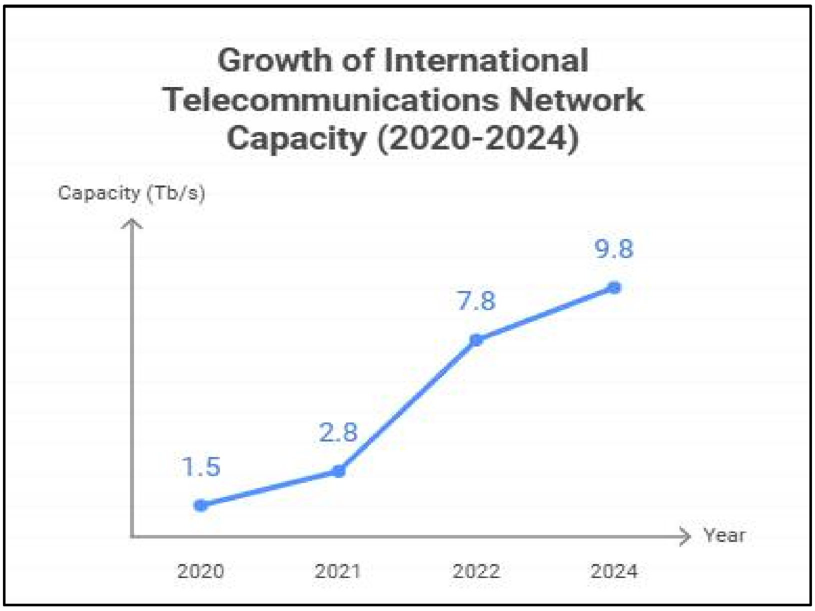
Source: Arab Digital Economy Index 2022 and Prospects for Recovery and Arab Economic Growth, p. 210

5.1. Readiness of infrastructures for digital transformation

Securing the telecommunications infrastructure is an essential element to ensure the quality of services and the continuity of the operation of various networks. For this purpose, all actors in this sector are working to strengthen and secure telecommunications networks through the implementation of several measures:

- Diversification of international access points through the establishment of new sea links in order to secure the international bandwidth of Algeria;
- Carrying out the procedures of expanding the current sea links with the establishment of new links that allow achieving a capacity of 7.8 TB per second currently compared to 1.5 TB in 2020;
- Strengthening the national transport network by deploying large-scale infrastructure while ensuring networking, and developing transport routes throughout the national territory - (Ministry of Communications, 2024);
- Creation of double standby systems by dealers.

Figure 08: Development of the capacity of the International Telecommunication Network



Source: Ministry of Telecommunications https://www.mpt.gov.dz

- **Electronic authentication**: Digital authentication or certificate aims to ensure the legality, integrity and security of information sent or stored electronically. It relies on the use of encrypted keys to secure data and transactions over the Internet

At the national level, electronic authentication is regulated by Law 15-04 of 11 Rabi Al-Thani 1436 corresponding to 21 February 2015, which defines the general rules related to electronic signature and authentication. Under this law, we find three complementary bodies(Ministry of Communications, 2024).

- National Authority for Electronic Attestation;
- Governmental Authority for Electronic Certification;
- and the Economic Authority for Electronic Certification.

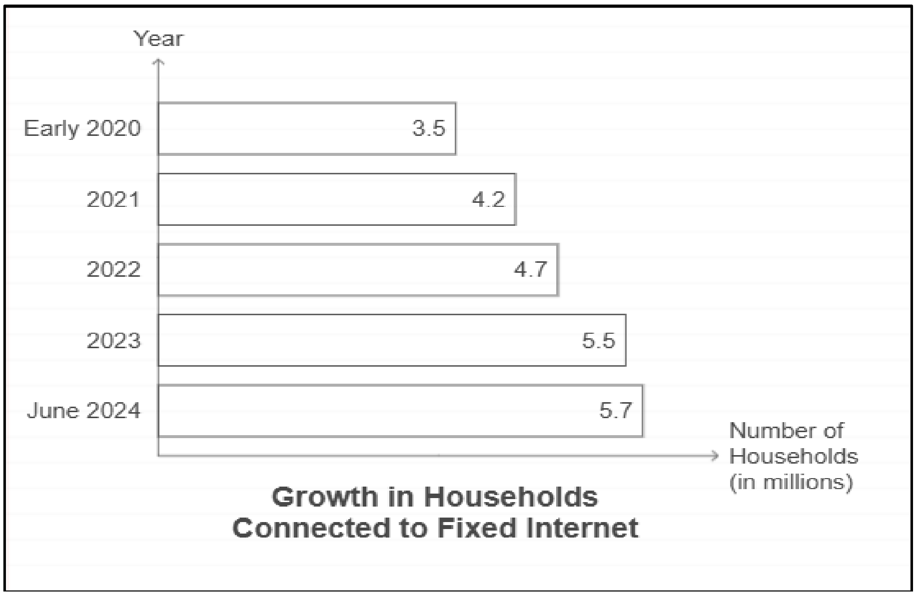
The aim is to gain international recognition ensuring alignment with other accreditation authorities across the world

- **The National Agencyfor the Promotion and Development of Technological Parks:** As an instrument for promoting and ensuring the development of information and communication technology, and contributing to the process of economic and social development

- The Ministry has also worked to improve the Internet access rate, by raising the number of families connected to the network on the one hand, as the strategy implemented by the sector aims to connect two-thirds of families Ministry of Communications, 2024). across the national territory to the Internet fixed by 2024, reaching the number of subscribers to 6 million families

In this regard, landline subscribers moved from 3.5 million in 2020 to 5.7 million in the first half of 2024.

Figure 09: Evolution of the number of households connected to the fixed Internet



Source: Done by Authors Ministry of Telecommunications https://www.mpt.gov.dz

The new urban poles as well as the new residential neighborhoods have also been connected with fiber optic technology until the end of the house. In addition to this positive development, Algeria is characterized by the peculiarity of deploying this technology across 58 states. At the continental level, Algeria is the second African country after South Africa to reach the threshold of one million subscribers with fiber optic technology until the end of the house. (وزارة الاتصالات، 2024)

5.2. Digital Governance

This dimension aims to meet the needs of individuals and society by providing and improving the provision of public services, in addition to doubling digital efforts to improve efficiency and transparency within the government sector.

Algeria has made great strides in the path of digital transformation, which would eliminate bureaucracy, adopt transparency in the conduct of public affairs, and strengthen the foundations of e-governance in embodiment of the principle of digital national sovereignty.

The most important steps in developing a digital governance strategy are: (Hussaina, 2014)

- The compatibility of the project with the principles and internal organization of government bodies;
- Improve the effectiveness of democratic processes;
- Expanding the communication network
- Based on inclusiveness and non-discrimination;
- Transparency and continuing to encourage e-participation;
- Coordinate between different sectors and levels of government and promote integration between them;
- Maintain and enhance citizen confidence by providing personal data protection and risk management

- Paying attention to the training and training of individuals within government bodies and taking the necessary measures to inform the public;
- To provide mechanisms for continuous evaluation and development.

6. Impact of ICT on key sustainable development goals

ICT is key to sustainable development and this can be seen in the link between it and all 17 key SDGs

Table 03: Role of ICT in the SDGs

Sustainable Development Goals	Role of Information and Communication Technology (ICT) in Achieving Sustainable Development Goals
Goal 5: Gender Equality	Online platforms have been used to protect human rights, meaning that women should enjoy the same opportunities to access knowledge and technology as men.
Goal 6: Clean Water and Sanitation	Smart water management technologies help reduce water waste. They also improve water quality and monitor pollutants in the water system, especially in urban areas.
Goal 7: Affordable and Clean Energy	The shift to renewable energy sources has led to a decrease in greenhouse gas emissions. ICT helps in managing energy production and renewable energy sources efficiently.
Goal 10: Reduced Inequality	ICT can provide equal opportunities, such as access to education, for marginalized communities and individuals with disabilities.
Goal 11: Sustainable Cities and Communities	Partnerships between stakeholders play a crucial role in creating sustainable societies using ICT and social media to facilitate communication among various parties.
Goal 12: Responsible Consumption and Production	The Internet of Things (IoT) and data analytics can improve supply chains, especially in agriculture and food production. This technology was valuable during the COVID-19 pandemic in maintaining supply chains and limiting waste.
Goal 13: Climate Action	Addressing the impacts of climate change requires the use of green technologies and sustainable practices.
Goal 14: Life Below Water	Monitoring and tracking systems enable the detection of marine pollution and support the protection of marine life and ecosystems.
Goal 15: Life on Land	Technology enables tracking and monitoring of biodiversity, which is crucial for preventing poaching and illegal trade, thus supporting wildlife conservation.
Goal 16: Peace, Justice, and Strong Institutions	ICT can be used to support social justice and peace by providing platforms for community participation and facilitating communication between institutions and communities, thereby strengthening governance.

Source: Arab Digital Economy Index 2022 and Prospects for Recovery and Arab Economic Growth P:150/151

Through the table, we notice how ICT contributes to facilitating the achievement of various sustainable development goals approved by the United Nations, as ICT contributes significantly to enhancing efforts to achieve sustainable development by benefiting from applications, programs, databases, cloud storage services and artificial intelligence technologies

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7. Conclusion

In light of the knowledge revolution and technological progress, information, technology and innovation occupy their place, especially in social and environmental economic development, and the foundations of impact on the course of development in the world are considered to meet the aspirations of everyone to a decent life, and sustainable development is achieved only when the objectives and procedures of management are environmentally applicable and economically practical and socially desirable.

The conceptual framework for digital transformation aims to demonstrate the growing footprint of ICT in achieving the 2030 Agenda for Sustainable Development, which was reduced to SDGs 9 and 17, while the impact of ICT extends to the majority, if not all, of the SDGs.Algeria has made great strides in achieving the goals of sustainable development, trying to keep pace with the era of technology and the modernization and digitization of many facilities in order to facilitate work and bring the administration closer to the citizen

Recommendations:

Finally, there are a number of recommendations that can be drawn from this study:

- Enacting laws to achieve sustainable development in various social, economic and environmental aspects in order to preserve natural resources;
- Providing the appropriate infrastructure to build the digital economy and contribute to achieving the Millennium Development Goals;
- The need to speed up overcoming the obstacles that prevent digital transformation and find the necessary solutions;
- Increasing the interest in the human element and improving the work environment and conducting periodic and continuous training for the human element by adapting them to the requirements of digital transformation;
- In addition to the need to learn about the successful experiences of different countries of the world in order to benefit from them.

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