Digital Government Authority
هـيـئـة الحكومة الرقمـيـة

Cloud Computing and its Role in Accelerating Digital Transformation and its Sustainable Impact in the Government Sector

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Contents

Executive Summary

The study aims to provide a clear and detailed vision on how cloud computing drives the digital transformation in the government entities of Saudi Arabia and to show that the rapid adoption of cloud computing services in various sectors will contribute to raising the efficiency, reliability, and capacity of digital transformation in addition to being a supportive means to achieve the strategic goals and directions of the digital government. This study includes important main topics, which are **as follows:**

- The overview of objectives, concepts, benefits, services, and importance of cloud computing and its related matters in specific detail based on the directions and strategies of the government entities, which is determined by the standards, commitments, governance, and guidelines of stakeholders and ecosystems related to them.

- The impact of adopting cloud computing and its services on Environmental, Social, and Economic Sustainability in various sectors in the government entities, and on the prosperity of the digital economy and the Saudi economy in achieving Saudi Vision 2030 and its goals, with presentation of models of successful local, regional and global experiences.

- Promoting and raising awareness of the importance of adopting cloud computing and its services in the Kingdom's digital transformation across all sectors, and its future benefits in attracting investments and service providers, and encouraging innovation.

This study provides reference information, strong evidence, and a comprehensive understanding to raise awareness of the importance of accelerating the adoption of cloud computing services and facilitating the decision-making process for business leaders and those interested in digital transformation across various sectors. It enables them to find the appropriate cloud strategy that contributes to environmental, social, and economic development effectively, efficiently, and sustainably in their institutions or organizations, which in turn reflects on strengthening the Kingdom's economy.

1. Introduction

1.1 Digital Government Authority (DGA) and the Government Cloud Office (GCO)

The Digital Government Authority (DGA) has launched the “Cloud Computing Accelerator Program for Government Entities” to enhance the adoption of cloud computing services in the government entities, enable innovation, promote the adoption of emerging technologies, raise productivity and efficiency, accelerate and develop digital transformation to an advanced stage of flexible, scalable performance at the lowest cost, time and effort. DGA has established the "Government Cloud Office (GCO)", which is an independent office concerned with accelerating, enabling and supporting government entities in the adoption journey of government cloud services, in addition to contributing to demonstrating the importance of cloud transformation to raise the Kingdom's ranking in international indicators related to e-government, through several important key tracks that have basic strategic objectives and standard indicators, and to enable government entities to contribute to achieving Saudi Vision (2030), sustainable development goals, and Saudi Arabia’s future directions and aspirations. These strategic tracks of the office are represented in three phases with its central objectives both in the near and long term **as follows:-**

1. The planning and development track, aiming to assess the current state of supply, demand and existing gaps, and subsequently develop and implement a cloud governance model for government entities, and provide controls, standards, and guidance.

2. The track of enablement and acceleration, to provide strategic support to government entities, which includes conducting feasibility studies, financial planning, developing digital models, designing and implementing awareness plans and diverse training programs aimed at building human, technical, and knowledge capacities.

3. The monitoring and compliance track, to monitor government entities' compliance with regulations, cost-efficiency concepts and practices related to cloud services, and issue periodic reports on the performance of entities in adopting cloud services and the impact achieved from their adoption.

The main objective of the GCO under the DGA is to demonstrate the importance of adopting cloud computing technology to provide effective cloud services and solutions for a pioneering digital government, and to create a transparent and rich cloud market, by increasing the adoption of the government cloud for all entities in Kingdom from the current level of (2023) of (24) percent to (50) percent by (2025), and to (80) percent by (2030). Therefore, the cloud will become a key enabler for digital transformation.

1.2 Overview of Cloud Computing and Digital Transformation in the World

Digital transformation plays a significant role in achieving global sustainable development. The advancement of information technology has become essential to enhance the efficiency of services for individuals, institutions, and government sectors. With the advent of the internet, numerous emerging technologies have evolved, enabling seamless integration and facilitation of electronic transactions and communications across service levels, management, and effective communication. Among these advanced technologies is cloud computing, which is considered a leading and strategic pillar. It provides a comprehensive infrastructure and a suitable environment with all its services, driving the achievement of digital transformation goals with high quality and efficiency. This enables governments to transition from paper-based work to advanced digital governments. Undoubtedly, digital transformation will expand the scope of development, change, and new transformations in all areas for those seeking to provide innovative solutions to achieve better quality when implementing their internal and external digital services.

Linking digital transformation with cloud computing is not a simple task. Transitioning to cloud computing technology systems will require a radical change in the organization's or entity's structures in terms of procedures, processes, business strategies, and the way digital transformations, services, and business models are implemented. Therefore, countries are competing and racing against time to move from traditional to digital management to leverage various advantages, keep pace with rapid global developments, and achieve the desired goals of the cloud computing adoption journey. The aim is to accelerate digital transformation and become strong, leading digital governments that govern the cloud, contribute to faster service delivery, and stimulate economic development.

1.3 Overview of Cloud Computing and Digital Transformation

Cloud computing will drive the global digital transformation to an advanced stage of flexible and scalable performance at the lowest cost and effort, and with positive results. Cloud computing technologies are among the most important global technological innovations in the modern era, as they contribute to the development and innovation of new models and ways to accelerate and govern businesses by providing a range of computing, storage and networking services over the Internet available anytime and anywhere, thus contributing to achieving operational efficiency and improving the performance of institutions and individuals.

Therefore, cloud computing can be used in various organizations and government sectors to ensure efficiency, cost saving, and expand the scope of services, cooperation and collaboration. The application of cloud computing depends on the needs of each sector or organization independently to maximize its benefits, enhance its performance, and increase its growth in a sustainable manner. From this standpoint, the Kingdom has adopted cloud computing as an important emerging technology with the approval of all communications and information technology organizations and relevant authorities. An independent government authority has been established under the name of the "Digital Government Authority (DGA)", whose roles include governing the work of the digital government cloud and clouds related to the digital government sector. The authority sets cloud computing policies, controls and standards for relevant government agencies and stakeholders. This is to achieve the objectives of Saudi Vision (2030) to diversify the economy, promote innovation, accelerate the digital transformation journey, and provide digital services in a distinctive and modern manner, allowing it to enable and sustain investment in the future, and develop the digital economy.

1.4 Advantages of Cloud Computing and Digital Transformation

Cloud computing is one of the fruitful emerging digital transformation technologies that keep pace with technological progress and the accompanying global knowledge revolution in various areas of life. There are many benefits to adopting this new technology, which meets the needs of the concerned institutes, **including:**

- Accelerating transaction processing, by eliminating routine, delays, and corruption. Where everything is available, known, and accessible quickly and easily.
- Optimizing operational efficiency, by streamlining the institution's working to obtain the services provided to the beneficiaries with higher quality and efficiency.
- Providing many opportunities to offer innovative services and surpass traditional methods of service delivery.
- Expanding and reaching a wider range and accessing a larger segment of customers and the public.
- Providing greater privacy, security, and confidentiality for data.
- The possibility of integrating cloud computing technology with digital transformation technologies, which **reflects positively in:**

1. Increasing flexibility, production efficiency, and competitiveness at work, while reducing the duration of work performance, and reducing costs.
2. Providing services at the highest levels to achieve the satisfaction of beneficiaries and users.
3. Facilitating the change management process, and improving the constructive interaction between the internal and external operations of the organization.
4. Creating numerous job opportunities, and qualifying human capabilities through training and practice to deal with the new digital environment.
5. Accommodating and embedding other assistive and advanced technologies such as artificial intelligence, the Internet of Things, blockchain and others, thanks to its enablement of flexibility and expansion through virtual simulation, which is the basis for the movement and execution of cloud computing operations, allowing for optimal use of its resources.

2. Cloud Computing Concepts

2.1 Definition of Computing and Cloud Computing and its Importance

Computing is defined as the transformation of activities, events, and actions from manual to electronic, by identifying the required steps through algorithms that must be programmed in one of the computer languages, to process data and convert it into information or retrieve it as data. As for cloud computing, it has been defined by the National Institute of Standards and Technology (NIST) as a suitable model for building a network on demand and obtaining a shared pool of computing resources (networks, servers, storage, applications, and services) that can be provided with less effort, management and cost. The results and outputs of computing are transmitted through the clouds, which is the Internet here, that provides computing services through this common and shared network anywhere and anytime, thus forming a new science and field in computer science, and can be used as a means of providing new useful services to the beneficiary.

The concept of cloud computing imposes itself as an alternative model to traditional systems in organizations by providing on-demand hosted services over the Internet. It is a tool that efficiently transfers information, data, and applications that are stored in remote locations provided by service providers to the beneficiaries. It is worth mentioning that the internal or on-premises computing of the organization provides both services and files, which are stored and maintained via internal servers. Cloud computing can leverage its resources and help facilitate the rapid transition of an institution to the cloud and reap its benefits.

The concept of cloud computing may evolve to include a broader concept known as government cloud computing or "e-government", which enables the linking of ministries and government institutions using all available devices, databases, software, and applications in their data centers, computing their various activities, providing all required services electronically, completing transactions, and simplifying procedures between departments and ministries via the Internet with greater transparency and higher quality.

2.2 Benefits and Characteristics of Cloud Computing

Cloud computing has many benefits. Perhaps one of the most important of these benefits is avoiding the problems of maintenance and development of information technology programs for the beneficiaries. The efforts of the beneficiaries are focused on using the cloud computing infrastructure from the advanced data centers provided by the cloud computing service provider, thus providing them with large storage spaces and service programs, especially the latest web technologies. The essential characteristics of cloud computing for users can be highlighted in several important points at various levels of individual, community, government, or global communication, **as follows:**

- The effective positive impact on cost saving of operations and providing services in a distinctive manner, which is evident through the speed of delivery, transparency, reduction of security risks, enhancement of accountability, efficiency, and effectiveness of the performance of cloud computing management operations and procedures.
- Simplifying and facilitating the interaction with services, and improving them on various available communication channels and tools that support the Internet in a way that meets the needs, expectations, and satisfaction of beneficiaries.
- Enabling flexible scalability in the cloud services and data centers, as well as business continuity, and easy access to information and data any time and anywhere for beneficiaries through any device connected to the Internet, whether was computer, mobile phone or otherwise.

2.3 Cloud Computing Models and Services

Cloud computing can be classified, based on the concepts and practices of the cloud into four main types of deployment models, which are **as follows:**

1. Private or Internal Cloud Computing: Rented and managed by a single customer for their own account, the data, security, and quality of service are under their full control.
2. Public or External Cloud Computing: It is the infrastructure of multiple customers, where their different applications are stored together on cloud servers, storage systems, and networks.
3. Community Cloud Computing: It is also an infrastructure for multiple customers, but here, they share and use the same applications.
4. Hybrid Cloud Computing: It is a combination of both private and public clouds, so that applications are distributed to both the private and public cloud, and the two clouds are called as a “Combined Cloud”.

Cloud computing represents a qualitative shift for central compute devices (mainframe computers), where everything within them is considered a service, now known as (Everything As a Service) (XaaS). This includes hardware, software, platforms, databases, and more, as an independent service. Through XaaS, computing services can be classified and the most appropriate ones can be selected on demand via the cloud type. However, three main service models are the most important, **as follows:**

- Software as a Service (SaaS): It is a modern software distribution model that allows customers to use software as a service over the Internet and access software and applications that have been hosted and published by the service provider. An example of this is the Google Drive application provided by Google.
- Platform as a Service (PaaS): It is similar to software as a service, and provides the user with an integrated development environment with its auxiliary software, enabling them to run, design, and choose the appropriate applications and manage the necessary tools for it. An example of this is the Google Applications Engine Platform.
- Infrastructure as a Service (IaaS): This is the foundational layer in cloud computing and refers to the delivery of the infrastructure, which is the Virtualization Environment Platform. Here, the user can benefit from managing access to network functions, virtual and dedicated machines, servers, and storage spaces. The performance of services depends on the performance of its infrastructure. Amazon Web Services (AWS) is an example of adopting the IaaS in the cloud.

Cloud computing technologies and applications are constantly evolving, as well as increasing and improving Internet speeds, so it can be said that in the near future, we will reach a stage where the beneficiary can run all his applications and business via the web using different cloud computing operating systems easily, efficiently and professionally, provided by cloud services provider with technical, practical and highly efficient technical expertise.

2.4 Cloud Computing Strategy for an Organization

Organizational leaders recognize the importance of having cloud computing strategies to align stakeholder goals, decisions, and activities with the future organizational goals of the organization. However, organizations with a well-designed strategy are better able to achieve business cloud results. A cloud strategy is a plan that describes how an organization will adopt, manage and optimize the cloud to achieve its business goals, and it should be a very clear vision of the role of cloud computing in the target organization. In order for any organization to have a unique strategy, **these points should be considered in the journey of transitioning to the cloud** :

1. Assessing the existing Information Technology (IT) environment and identify critical areas and elements within the organization that can benefit from cloud services. This will help to determine the right mix of public, private, and hybrid cloud solutions and its perfect services.
2. Choosing the most appropriate cloud provider that meets the security, compliance, and cost needs of the organization. This makes it easy to explain the steps needed to move the necessary applications and data to the cloud. This may include redesign, data migration, and employees training on the new systems and tools offered by cloud service providers.
3. Aligning the organization's business goals with the benefits of cloud computing, and explaining how to overcome the possible risks. As a result, it is important to know and clearly state why the organization is interested in the cloud at the beginning and what the organization is trying to achieve from it.

Currently, it can be said that there is a trend for new organizations to adopt multi-cloud and hybrid strategies by leveraging many cloud service providers to adopt cloud services inside and outside the organization. This approach provides more flexibility, accessibility, and cost optimization. However, business leaders must identify and choose effective cloud strategies for their organizations and the type of adopted services based on the requirements, needs, and key goals to be achieved.

2.5 Cloud Computing and its Support for Emerging Technologies

The revolution of emerging technologies in cloud computing and digital transformation is one of the most important fundamental factors that helped the concept of cloud computing grow to the highest levels, and contributed to technological progress and development. The adoption of these technologies leads to positive changes in sectors and improves the performance and efficiency of projects and businesses in several aspects. Therefore, the Digital Government Authority (DGA) was keen to support and encourage government entities to adopt emerging technologies that are still in the stage of growth and development. Among the most important of these emerging technologies for cloud computing that have an effective and tangible impact and have proven their effectiveness in various cloud computing applications, are: Artificial Intelligence (AI), the Internet of Things (IoT), and blockchain. Although these emerging technologies represent a breakthrough, their association with cloud computing significantly increases their basic capabilities. The concepts of these innovative technologies, and their impact on some aspects of life, as well as on Saudi government sectors that have successful practical experiences with them, will be discussed in the following sections of this report.

2.5.1 Artificial Intelligence (AI)

In theory, the concept of artificial intelligence is the process of developing computer systems to be able to perform tasks that usually require human intelligence, such as the ability to learn, infer reason, and represent knowledge, visual perception, speech recognition, decision-making, planning and translation between languages, and so on. Artificial intelligence depends entirely on the abundance of data and algorithms, and when integrated with the cloud computing environment, high accuracy can be achieved in processing data, collecting information, representing it, searching and inferring from it, and facilitating the creation of organizational operational structural models, thanks to the speed and ease of communication between these computers, and the ability of their huge processors to find appropriate solutions, decipher codes, facilitate operations, sustain work, and raise productivity with high efficiency. In addition, it provides innovative and useful services that touch the satisfaction of beneficiaries, individuals, organizations and governments.

Artificial intelligence, in its various forms, is used in important areas of life, such as medical applications, logistics, and so on, for its ability to solve problems, sequential logical thinking, and rapid gradual conclusions with high accuracy and efficiency. One of the local examples that has adopted artificial intelligence technology is the telecommunications sector, where it was facing a significant challenge in the difficulty of dealing with fraudsters by traditional methods, and it was necessary to provide analytical solutions to ensure security through big data analytics. Via the AI technology a model was developed to detect fraudulent patterns, identify preventive methods, and develop proactive analytics and scenarios to prevent fraudulent operations by classifying risks at the level of individuals, companies, and distributors. The AI technology has made a difference and impact in the telecommunications sector, as nearly half a million frauds were processed daily, fraudulent activities being detected and addressed in real-time, as well as preventive methods being periodically enhanced, while ensuring a safer and more reliable experience for telecommunication users.

In fact, artificial intelligence has multiple programming languages, and as some scientists classify it, it is the active science, and thus it is the science of the present, and future and constantly evolving. And it is classified and considered as a part of the fifth generation of computer software, which will be one of the most important supporting and distinctive technologies for cloud computing in its various directions.

2.5.2 Internet of Things (IoT)

The Internet of Things is a network of connected smart devices, people, and systems that enable s data exchange, integration and analysis to achieve efficiency and innovation. This emerging technology is considered a complement that aims to develop and improve life in a way that keeps pace with modern times, and is widely used in modern cities. When linked with modern systems, especially cloud computing, it can allow the creation of a social environment with added value and improved quality of life, while promoting innovation in various areas of life, and contributing positively economically through cost rationalization. For Example, IoT can reduce the cost of living at the individual, social and governmental levels. There are many aspects of cost rationalizations of this emerging technology and its applications, including the rationalization of energy consumption, traffic, weather forecasts, and so on, which benefit at all levels.

The Internet of Things is all that the Internet can recognize through the known Internet protocols. It is an effective tool and technology that helps in collecting and analyzing data, which contributes to improving the infrastructure, and raising the level of services provided to beneficiaries by IoT devices, which are a group of connected devices and technical means that facilitate communication between devices and the cloud, as well as between the devices themselves by connecting to the Internet. These devices use various tools, sensors, actuators, artificial intelligence tools, and others to collect and activate data in real-time to improve various aspects of life, and allow the freedom to operate and control them from near and far.

Saudi Aramco, from the energy sector, is one of the local examples of entities that have utilized the IoT technology in integration with cloud computing. Saudi Aramco was able to establish a complete system in the Khurais oil field using thousands of IoT sensors to monitor and predict what happens in the oil wells. Thanks to the field's use of this digital technology, energy consumption was reduced by (18) percent, maintenance costs by (30) percent, and inspection time by about (40) percent, increasing the operational efficiency of the field.

2.5.3 Block Chain

The blockchain technology tracks, organizes, and records data movements between sender and receiver, linking them to a robust system that ensures flexibility in working between users in a massive cloud database, allowing it to be tracked and detailed information about data flow from two parties (Peer to Peer) easily and confidentially. This technology is often used in financial transactions, transfer of ownership between individuals and institutions, and completion of transactions without the intervention of a third party, so that no one can tamper with or access it. It can be said and confirmed that the integration of blockchain technology with cloud computing results in a new innovative approach with characteristics and features such as decentralization between devices, transparency, privacy, non-modifiability with scalability, and accessibility.

The principle of blockchain is based on the availability of a decentralized and distributed ledger, “an electronic record" that records and manages all transactions and dealings over a network of decentralized computers in the form of blocks. Each "block" in the chain contains a number of transactions, and these blocks are linked together in linear chronological order and tight encryption, thus this decentralized nature ensures that each code is unique and cannot be duplicated.

In this way, data security can be enhanced, transparency improved, and processes simplified by using a decentralized, and tamper-free ledger to store data, making data breaches nearly impossible. In addition, every transaction is recorded and tracked, thus increasing accountability and trust among users. The integration of this technology not only transforms how companies and their individuals work, but also creates new opportunities and efficiencies across various industries, especially when linked to cloud computing concepts and its wide and innovative applications, which will allow ease, empowerment, and reliability with higher quality and efficiency for the exchange of data, information and various operations on them, in addition to the availability of diverse and interconnected services with greater strength, ensuring access to the beneficiary quickly and anywhere. Blockchain is a technological opportunity that can be used for some of its services in the logistics and data management sectors.

An example of the adoption of this technology in the Kingdom, is the Saudi Customs linking its "Fasah" platform with TradeLens, a company specialized in blockchain technology, to improve and secure maritime shipping operations, which will lead to increased operational efficiency, simplification of customs processes, and improvement of exports and related services, ensuring follow-up of details and steps of journeys with compliance with laws and regulations. Blockchain technology will be a catalyst for IoT applications and will form an important database for all devices and applications connected to the Internet in the near future.

3. Sustainable Positive Impacts of Cloud Computing Adoption

3.1 The Concept of Sustainable Development

Sustainable development refers to the development of land, cities, communities, as well as businesses, in such a way that improves living conditions for all individuals without increasing the use of finite natural resources. This ensures increased economic growth, contributes to social development, and preserve natural resources. With the spread of information and communication technologies, especially cloud computing and its associated emerging technologies, and the adoption of its various services by countries, communities, individuals and institutes, new societies will emerge that aspire knowledge, development and positive change. All of this reflects on the promotion and sustainability of development in various sectors and areas of life, and the achievement of sustainable development goals at the economic, social and environmental levels. The economic, social, and environmental predictions of the Kingdom of Saudi Arabia point to sustainable growth due to the presence of digital infrastructure, the provision of necessary skills, and the establishment of innovative companies. Therefore, rapid adoption of cloud computing services in the public and private sectors will be an effective driver for the growth of the digital economy and digital transformation and an important pillar for the adoption of cloud computing with more accurate, efficient and effective standards. In fact, the digital sustainability journey will become an ongoing process and an integral part of the daily lives of citizens, especially with the continuous development of emerging technologies that allow investment in the world of cloud computing in a sustainable way.

Our country, the Kingdom of Saudi Arabia, thanks be to God Almighty, is taking rapid steps toward building a prosperous future by achieving the elements of complete sustainability, and its highest estimations through improving the quality of life with various digital services in all areas of life. This ensures a healthy environment, enhances well-being, utilizes lifelong learning, and facilitates participation, balance and communication between work and life. Thus, contributing to achieving the satisfaction of beneficiaries, enabling and facilitating business, investments, partnerships, initiatives, and innovations, and supporting and encouraging organizations or entities in finding platforms and ecosystems to accelerate digital transformation, and deal with it internally, while effectively engaging the community externally in the services provided.

The Kingdom aims to reach high estimations and percentages in the adoption of cloud computing, digital transformation, and its services in the future. It is expected that the Kingdom will achieve a rate of (90) percent in the index of the speed of digital transformation of government agencies, as well as the index of beneficiary satisfaction with digital services for the year (2025). In the E-Government Development Index (EGDI), it aspires to be among the top ten countries in the world by (2030).

3.2 Sustainable Economic Impact

The increasing need for cloud infrastructure and services by organizations in the Kingdom will attract foreign cloud service providers to invest in the Kingdom. This will facilitate the adoption of cloud computing for targeted organizations, enable digital innovation, bridge the growing demand gap for government cloud adoption, and accelerate digital transformation to develop e-government. The government will work to increase spending and investment in cloud computing, promote investment, sustainability, and the growth of the digital economy. Global cloud service providers such as Oracle, Microsoft, Alibaba, Google, and others have been attracted to invest in the Kingdom and facilitate cloud investments through the Cloud Computing Framework Agreement and the establishment of a transparent and thriving cloud market. Therefore, the purchase of cloud services was facilitated via the "Etimad" platform, which is the Government e-Financial Services Platform, via a new budget item that was created in the budget of government entities for cloud computing. Saudi Arabia's can become a regional technology hub by accessing efficient cloud services to be a leading digital government.

According to a report by Gartner, an American technology research and consulting firm, the percentage of spending by the government of Saudi Arabian on the Information and Communication Technology (ICT) sector is the highest worldwide. It is expected to grow at a compound annual growth rate of (2.89) percent from (2018) to (2024), as the expected market size in this sector will reach approximately (56.71) billion riyals by (2024). The Kingdom is expected to witness growth at a compound annual growth rate of (16.85) percent in the value of cloud services from (2024) to (2029), based on the market study and report of Mordor Intelligence, which provides predictive advisory services for the market and business ecosystems.

Future expectations, which emerge from measuring the indicators of global organizations, indicate an increase in economic value due to the steps, initiatives, and projects in improving the business environment, attracting foreign investment, creating numerous job opportunities, and promoting innovation in cloud and digital services, all of which contribute to reducing capital expenditures and converting them into operational expenses at a lower cost and a sustainable economy that ensures the quality of life, and is enhanced by improving government services in all public and private sectors and government agencies.

3.3 Sustainable Social Impact

Cloud computing allows the transformation of various services internally and externally to beneficiaries by adopting new business models to improve the quality of community life, the possibility of constructive communication that directly drives the demand for these services and the developed models to operate them, ensuring the professional and practical practices, simplifying organizational management, and encouraging cooperation and innovation in the development of government services and products. In addition, it allows for frequent meetings, even if remotely, to perform and master tasks, in addition to developing the basic human capabilities of the community technically, educationally and training wise in a new and improved way. This is done by enriching the understanding of cloud computing, its benefits, and its ability to diversify the use of applications and systems associated with it along with comprehensive familiarization and learning of its accompanying emerging technologies and new services, which positively reflects on the performance of the individual and society, giving confidence to them and facilitating social participation, and contributing to generation of a conscious smart generation and a sophisticated developing society. An example of social sustainability is the smart cities usage of cloud computing and its technologies to improve the community environment and keep pace with the best of modern life in its various uses in different areas of life.

In (2022), the Ministry of Communications and Information Technology (MCIT) in the Kingdom of Saudi Arabia presented an initiative and memorandum of understanding with the International Business Machines Corporation (IBM) for a period of five years, and the Kingdom spent nearly (4) billion riyals to raise and improve the skills of (100,000) Saudi citizens in various technical fields, including the IBM cloud, in order to increase cloud knowledge and empower the workforce in this field.

The Global Cloud Computing Ecosystem Index, developed and reviewed by the (Massachusetts Institute of Technology (MIT) Review), which promotes the availability of cloud services according to the quality of technology, regulations, cybersecurity, and the talent and human capacity used for it, reveals that the Kingdom ranks (55th) out of (76) countries, which indicates the success of cloud computing strategies and digital transformation strategies in the Kingdom and their sustainable impact on the rapid development of society and its individuals.

3.4 Sustainable Environmental Impact

Cloud services themselves constitute valuable tools for continuously improving energy and environmental efficiency. In fact, the use of smart cloud-connected systems, powerful cloud-enabled devices, and the latest accompanying technologies such as artificial intelligence, the Internet of Things, blockchain, and other emerging technologies can utilize, and analyze available information and data in real-time. This can lead to positive gains in reducing energy, electricity, water efficiency, and improving the environment. The cloud computing technology and its adoption of devices, technology, and equipment to transfer data centers in the traditional environment and what relates to it is itself a technical means and solution to reduce and rationalize the consumption of electricity and water, reduce greenhouse gases, and change the current environments into greener environments, that are cleaner, more spacious, and less costly to live in safely, healthily and stably with high quality, efficiency and permanent well-being for individuals and communities. In addition, the cloud contributes permanently to raising the quality of digital government services, making the environment itself a permanent incentive and return for government digital investment.

In this field, the Kingdom has provided the necessary financial support to achieve this sustainable environmental impact in creating a comprehensive cloud ecosystem enabled by the latest technology systems to create an improved environment and competitive digital services through the formation of what is known as smart cities to manage and monitor various city systems such as transportation, energy, water, waste management, public safety, emergency and others. one example of modern smart cities in the Kingdom is the "NEOM Smart City", a futuristic sustainable city that embraces the concept of modern life by creating a smart and fully connected urban system with the latest technologies and innovations such as artificial intelligence, robotics, renewable energy, and others. The city also focuses on quality of life and social well-being, while attracting talent, entrepreneurs, and investing on a global scale in the diverse and inclusive environment of this smart city. This massive project to adopt the "NEOM Smart City" has been supported by the Saudi Public Investment Fund (PIF) with a value of (500) billion dollars, covering an area of (26,500) square kilometers, and it will be powered by (100) percent renewable energy.

3.5 Regional and Global Experiences

3.5.1 Regional Experience

Government cloud computing in the state of Qatar began in (2000), as a pilot project to explore the possibility of implementing Qatari cloud computing. It started by selecting an important government service, namely residency renewal, which has a significant impact on society in terms of facilitating and simplifying transaction procedures and operations. Cooperation was established with four relevant entities involved in the service, namely: the Ministry of Interior (service provider), Qatar National Bank (the provider of the electronic payment gateway), the Central Bank (service host), and Qatar General Post (as the authorized entity for document delivery). The service works by having the user log in to the government service website hosted in the cloud using a one-time password obtained at each log-in session. Then, the user enters the identification number of the residency they wish to renew, and the number of years for renewal. The system then sends the information to the Ministry of Interior to fetch the renewal fee amount. When the transaction is executed, the amount is deducted from the user's account at Qatar National Bank, and thus the process is executed on the Ministry of Interior devices. After that, the renewed residency and payment receipt are delivered to the user via Qatar Post within a period not exceeding (24) hours, where as this service used to take days or weeks to complete. This remarkable success was an incentive to continue, and a challenge to develop, starting a new phase of the government cloud computing project in Qatar, where more services were added.

3.5.2 Global Experience

One of the successful global experiences with cloud computing technology is India's experience with the digital education platform. They established a website for India's education services called (Indiaeduservices.com), which is a cloud computing platform that offers software in the cloud as a service (Software as a Service (SaaS)). This effective model enabled India to create a comprehensive integrated educational environment that provided education professionally, reaching large areas of India. It solved the problem of the increasing population every year and the difficulty and high cost of building schools, institutes, and universities . It also addressed the gap in the increasing demand to meet the needs and services of education at all stages, levels and cadres of higher, general, and private education, and harnessed investment for that purpose. As a result, it can be said that cloud computing, by providing software as a service in India's education, provided the most suitable and best solution to enable education in an attractive and dynamic way for learners, and educational cadres, and their various institutions, in addition to providing unlimited necessary support to facilitate the education process and its services, making education accessible to all with equal opportunities, and reducing the economic and social gap between members of society.

3.6 The Contribution of Cloud Computing to the Digital Transformation of the Kingdom in Global Indicators

The Kingdom has contributed to the expansion of cloud computing services and their adoption as an emerging technology in all its public and private sectors in a stimulating, continuous fruitful manner, resulting in maturity indicators that increase growth, drive the improvement of the Gross Domestic Product (GDP), and enhance innovation and the speed of digital transformation with its diverse services. These indicators, which are considered accelerators for adopting cloud services, have contributed to the maturity of technology and digital capabilities in the Kingdom, which has enhanced productivity, improved capabilities further, and significantly increased proficiency in the use of new technology and digitization significantly in all government sectors. As a result, the Kingdom has advanced in a number of international digital indicators, **including**:

1. The E-Government Development Index (EGDI), which is one of the most important indicators published by the United Nations globally, where the Kingdom ranked (31st) in (2022) compared to (43rd) in (2020), as a result of the previous and current simultaneous fruitful investments in the telecommunications and technology sector, contributing to improving human capabilities in health and education, and the availability and increase online services for users.

2. The Government Technology Maturity Index (GTMI), issued by the World Bank Group, which measures the maturity and completion of government entities in the necessary tools for digital technology, supporting their main systems, enhancing service delivery, generalizing beneficiary participation, and enabling its supporting factors, the Kingdom achieved third globally and the first place regionally.

3. The Government Electronic and Mobile Services Maturity Index (GEMS) issued by the Economic and Social Commission for Western Asia (ESCWA), which measures the maturity of government services provided through mobile applications and electronic portals and in this index, the Kingdom ranked first in the Arab world.

At the internal level, the government entities in the Kingdom were able to reach (85.53) percent in the digital transformation measurement index for the year (2023), measuring the follow-up of progress of their digital transformation journey in accordance with best practices and standards, which will contribute to the development of digital government and the Kingdom's continuous progress in international indicators.

4. Conclusions, Risks and Recommendations

4.1 Research Conclusions

Cloud computing and its services are considered the third technological revolution after computers and the Internet. It is a promising concept and a modern flexible technology that relies in its way of work on three important pillars, namely the Internet, remote data centers and virtualization technology. It allows for the operation of software and applications, data storage and sharing computing resources such as networks, servers and bandwidth by providing them from an external service provider with high efficiency and reliability. It will lead the digital transformation in the entities or institutions adopting it, to wonderful technical, human and material solutions in various areas of life by transforming the Internet into a large repository where computing resources are available in the form of different services as a public utility, at a lower cost based on demand from anywhere, and at any time, with high speed and minimal administration effort or interaction through the service provider. This big data will be stored and secured in it, and will not be allowed to be accessed it except through the applications used or the users authorized to do so.

The world is moving rapidly and positively toward adopting this technology, because of its contribution to the sustainability of the economy, society, and the environment by providing advanced and facilitated services that make life easier and raise its quality, and set a value and benchmark that allows individuals, organizations, and countries to continue their work and strengthen their performance in various areas of life, which always pushes them towards achievement and work, promote innovation, and reaches optimal performance.

In conclusion, this study has shown the sustainable impact of cloud computing and its leadership in digital transformation in all sectors of the Kingdom as a result of the improvements provided by cloud computing, which contribute to enabling the economic environment, stimulating innovation and entrepreneurship, in addition to improving the efficiency of government operations and services. The tangible efforts of the government of the Kingdom in the rapid adoption of cloud computing, digital transformation, and its services will result, God willing, in building distinctive digital economy that enhances its sustainable economic, societal, and environmental worth. It will be a country with a leading digital government with a significant impact at the internal, regional, and global levels in the internal and global indicators, and will be capable of achieving sustainable development, and ensuring the continuation of a decent life for its people from one generation to the other.

4.2 Risks and Future Recommendations

Government entities in the Kingdom seek to take advantage of the great opportunities provided by cloud computing to enhance performance and operational efficiency. Government entities should also be aware of potential risks and turn them into opportunities that support improvement rather than be obstacles. Most notably, risks related to data security and protection, such as the risks of hacking, leakage and unauthorized data copying, as well as potential threats of disruption to services due to cyberattacks. A further risk is lack of competencies and skills, which can lead to increased operational risks, gaps and technical errors, and the difficulty of addressing or reducing their impact quickly and effectively. In addition to the above, regulatory risks can be considered one of the main risks of adopting cloud solutions, so clear procedures, legislation and regulatory controls must be developed to identify needs and implement appropriate strategies, while considering the need to keep pace with the rapid developments in the field of cloud computing and related technologies.

Here, we can offer a set of recommendations to enhance the adoption of cloud computing services in the Kingdom's government sector, address the aforementioned risks, and maximize the benefits of the cloud infrastructure. **The most important recommendations are as follows:**

First, review and develop data security and protection regulations as well as policies to keep pace with the rapid expansion and growth in government adoption of cloud computing. This will enhance the security and stability of cloud computing services and the sustainability of their infrastructure.

Second, review and develop standards, policies, and guidelines in collaboration with relevant regulatory bodies to regulate usage and ensure compliance by government entities in adopting cloud computing. This should meet the needs of the local market, promote local content, and foster collaboration with international organizations for knowledge exchange.

Third, promote cloud computing adoption through awareness programs, workshops, and training courses. These should target leaders to raise awareness of its value and benefits, as well as specialists to enhance the necessary technical skills and capabilities.

Finally, encourage innovation and the development of innovative cloud solutions that meet the needs of government entities. This involves utilizing the capabilities of cloud computing and its services more effectively and achieving a comprehensive digital transformation that contributes to strengthening resilience, economic growth, and sustainable development in the Kingdom.

It is worth noting that the Kingdom has undertaken numerous efforts related to the risks and recommendations mentioned above to accelerate the adoption of cloud computing services. **Some of the most notable efforts include:**

- The Ministry of Communications and Information Technology (MCIT) issued the "Cloud First Policy" in the Kingdom, to accelerate the adoption of cloud computing services by government entities, improve operational efficiency, and reduce costs.

- The Digital Government Authority (DGA) has launched the "Cloud Computing Accelerator Program for Government Entities," as mentioned in the introduction of this report as well as released the "Cloud Computing Adoption Guide for Government Entities". The authority has also included, in its third edition of the "Digital Transformation Standards," which are mandatory standards for government entities, specific measurements regarding the extent of compliance by government entities with cloud adoption.

- The Communications, Space and Technology Commission (CST) issued the Cloud Computing Regulatory Framework (CCRF) in the Kingdom, based on international best practices. This framework defines the rights and obligations of all parties, including service providers and customers, whether they are government entities, institutions, or individuals.

- The National Cybersecurity Authority (NCA) issued a comprehensive document that defines cloud security controls and controls for cloud service providers and customers called "Cloud Cybersecurity Controls (CCC)", which complement the basic cybersecurity controls issued by the authority.

- The National Data Management Office (NDMO) at the Saudi Data and Artificial Intelligence Authority (SDAIA) has developed a regulatory framework for national data management, governance, and personal data protection in the Kingdom's government sector. This framework also includes private sector partners who deal with government data.

5. References

1. Akerman, I. (2022, May 18). Inside NEOM: Saudi's $500bn smart megacity, from https://www.agbi.com/construction/2022/05/neom-is-a-vision-of-the-future.
2. Algunaim, Khalid [Digital Government Authority] (2023, march 18). The Incorporation of AI in Government Technologies [Video]. YouTube, from, https://www.youtube.com/watch?v=mYgd5cX6Toc.
3. Al-Sayyid, K. (2004). Origins of Artificial Intelligence. Al-Rushd Publishers Library.
4. Amazon Web Services. (n.d.). What is Artificial Intelligence (AI), from, https://aws.amazon.com/ar/what-is/artificial-intelligence.
5. Chao, L. (2015). Cloud Computing Networking: Theory, Practice, and Development. United States: CRC Press.
6. Cloud Academy Team. (2018, January 25). Separating multi-cloud strategy from hype. Cloud Academy, from https://cloudacademy.com/whitepapers/separating-multi-cloud-strategy-from-hype.
7. Costello, K. (2021, April 6). The Cloud Strategy Cookbook, from, https://www.gartner.com/smarterwithgartner/the-cloud-strategy-cookbook.
8. Davies, J., & Fortuna, C. (2020). The Internet of Things: from Data to insight.
9. Digital Government Authority OSS Adoption Strategy. (2022). Digital Government Authority, from https://dga.gov.sa/sites/default/files/2022-08/Digital%20Government%20Authority%20OSS%20Adoption%20Strategy.pdf.
10. Digital Government Authority. (n.d.). The Results of the 11th Measurement for 2023, from https://dga.gov.sa/ar/the-results-of-the-11th-measurement-for-2023.
11. Doe, J. (2023, January 1). Sustainability Excellence. Sustainability Excellence. https://sustainability-excellence.com.
12. Finance Strategists. (n.d.). Blockchain, from https://www.financestrategists.com/wealth-management/blockchain.
13. Google Cloud. (n.d.). Blockchain customers, from https://cloud.google.com/customers/blockchain.
14. Government of Saudi Arabia. (n.d). Digital Transformation, fromhttps://www.my.gov.sa/wps/portal/snp/aboutksa/digitaltransformation.
15. Hwang, K., Fox, G. C., & Dongarra, J. J. (2013). Distributed and Cloud Computing: From Parallel Processing to the Internet of Things. Elsevier Science.
16. Kingdom of Saudi Arabia. (2021). Vision 2030, from https://www.vision2030.gov.sa.

17. Ministry of Communications and Information Technology. (2022, July 16). Boosting Saudi Arabia's Positioning as Regional Hub for Technology and Innovation: Strategic Partnership with IBM to upskill 100,000 Saudis, from https://mcit.gov.sa/en/news/boosting-saudi-arabias-positioning-regional-hub-technology-and-innovation-strategic.
18. MIT Technology Review Insights. (2022). Global Cloud Ecosystem Index 2022, from https://www.technologyreview.com/2022/04/25/1051115/global-cloud-ecosystem-index-202215.
19. Mordor Intelligence Research & Advisory. (2024, January). Saudi Arabia Cloud Services Market Size & Share Analysis - Growth Trends & Forecasts (2024 - 2029). Mordor Intelligence, from https://www.mordorintelligence.com/industry-reports/saudi-arabia-cloud-services-market.
20. Rajeev, N. (n.d.). Cloud Computing: A Practitioner's Guide.
21. Saudi Arabia, C. S. T. (n.d.). Cloud Computing Technology Overview and Market Outlook, from https://www.cst.gov.sa/ar/mediacenter/researchsandstudies/Documents/Cloud_Computing_Technology_Overview_and_Market_Outlook.pdf.
22. Saudi Aramco. (n.d.). Digitalization, from https://www.aramco.com/ar/what-we-do/energy-innovation/digitalization.
23. Saudi Press Agency. (2021, August 23). Economic / Customs connects the Fasah electronic platform to the TradeLens system of Maersk and IBM, from, https://www.spa.gov.sa/w811330.
24. United Nations Economic and Social Commission for Western Asia. (n.d.), from https://www.unescwa.org.
25. United Nations. (2022). UN E-Government Survey 2022. United Nations Public Administration Network, from https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2022.
26. Velte, T., Velte, A., & Elsenpeter, R. (2009). Cloud Computing: A Practical Approach. McGraw Hill LLC.
27. World Bank. (2022, October 21). GovTech Maturity Index (GTMI) Data Dashboard, from https://www.worldbank.org/en/data/interactive/2022/10/21/govtech-maturity-index-gtmi-data-dashboard.
28. Yassin, N. (2014). Cloud Computing for Libraries: Solutions and Applications. The Arabi for Distributions and Publications.

6. Acronyms

• Amazon Web Services (AWS)	• خدمات متصفح الأمازون
• Artificial Intelligence (AI)	• الذكاء الاصطناعي
• Aramco	• شركة أرامكو السعودية
• Block Chain	• سلسلة الكتل
• Cloud Computing Regulatory Framework (CCRF)	• الإطار التنظيمي للحوسبة السحابية
• Cloud Cybersecurity Controls (CCC)	• ضوابط الأمن السيبراني
• Cloud First Policy	• سياسة السحابة أولا
• Combined Cloud	• سحابة مجتمعة
• Community Cloud Computing	• السحابة المجتمعية
• Communications, Space and Technology Commission (CST)	• هيئة الاتصالات والفضاء والتقنية
• Digital Government Authority (DGA)	• هيئة الحكومة الرقمية
• Economic and Social Commission for Western Asia (ESCWA)	• منظمة الإسكوا (اللجنة الاقتصادية والاجتماعية لغربي آسيا)
• E-Government Development Index (EGDI)	• مؤشر تطور الحكومة الإلكترونية
• Essential Cybersecurity Controls (ECC)	• ضوابط الأمن السيبرانية الأساسية
• Etimad Platform	• منصة اعتماد
• Fasah Platform	• منصة فسح
• Gartner	• شركة جارتنر
• Google	• شركة قوقل
• Google Applications Engine Platform	• منصة محرك تطبيقات قوقل
• Google Drive	• تطبيق قوقل درايف
• Government Cloud Office (GCO)	• مكتب السحابات الحكومية
• Government Technology Maturity Index (GTMI)	• مؤشر نضج التقنية الحكومية
• Government Electronic and Mobile Services Maturity Index (GEMS)	• مؤشر نضج الخدمات الإلكترونية والمتنقلة الحكومية

• Gross Domestic Product (GDP)	• إجمالي الناتج المحلي
• Hybrid Cloud Computing	• السحابة الهجينة
• Indiaeduservices.com	• منصة خدمات التعليم الرقمية في الهند
• Information Technology (IT)	• تقنية المعلومات
• Infrastructure as a Service (IaaS)	• البنية التحتية كخدمة
• Information and Communication Technology (ICT)	• الاتصالات وتقنية المعلومات
• International Business Machines Corporation (IBM)	• الشركة الدولية لآلات الأعمال
• Internet of Things (IoT)	• انترنت الأشياء
• National Cybersecurity Authority (NCA)	• الهيئة الوطنية للأمن السيبراني
• National Data Management Office (NDMO)	• المكتب الوطني لإدارة البيانات
• Ministry of Communications and Information Technology (MCIT)	• وزارة الاتصالات وتقنية المعلومات
• MIT Technology Review	• المراجعة التقنية لمعهد ماساتشوستس
• Mordor Intelligence	• شركة موردور إنتليجنس
• National Institute of Standards and Technology (NIST)	• المعهد الوطني للمعايير والتقنية
• Platform as a Service (PaaS)	• منصة البرمجيات أو المنصة كخدمة
• Peer to Peer	• طرف إلى طرف
• Private or Internal Cloud Computing	• السحابة الخاصة أو الداخلية
• Public or External Cloud Computing	• السحابة العامة أو الخارجية
• Public Investment Fund (PIF)	• صندوق الاستثمارات العامة
• Software as a Service (SaaS)	• البرمجيات كخدمة
• TradeLens	• شركة تريدلنس
• Virtualization Environment Platform	• منصة البيئة الإفتراضية
• XaaS	• خدمة أي شيء

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