Challenges and Risks of Artificial Intelligence in Achieving the Kingdom of Saudi Arabia's Vision 2030

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Abstract

Artificial intelligence technologies are the most modern developments that the world is witnessing at the present time, and most countries of the world seek to exploit these technologies for the great potential and opportunities they provide in developing and improving various economic, social and political aspects. The Kingdom of Saudi Arabia gives great attention to developing and adopting artificial intelligence applications. This study aims to study and analyze the challenges and risks resulting from the use of artificial intelligence technologies in the context of achieving the goals of the Kingdom of Saudi Arabia's Vision 2030, of which approximately 66 goals depend on artificial intelligence and big data technologies. The study adopts the methodology of descriptive analysis and systematic review of the literature related to the challenges of artificial intelligence in the public sector. The study presented a model that classified the challenges into six different categories: the technical challenges category, the economic challenges category, the socio-cultural challenges category, the legal and ethical challenges category, the organizational challenges category, and finally the political challenges. This classification provides a reference framework that helps decision-makers develop effective strategies to address these challenges and enhance the use of this technology in a way that serves the comprehensive and sustainable development of the Kingdom of Saudi Arabia.

Keywords: Artificial Intelligence, Challenges, Risks, Vision 2030, Kingdom of Saudi Arabia.

1. Introduction

Artificial intelligence technologies are considered one of the most modern developments that the world is currently witnessing, and many countries seek to benefit from these technologies for the enormous potential and opportunities they offer in improving and developing various economic, social and political fields. Accordingly, the importance of using artificial intelligence in achieving sustainable development goals and implementing the strategic visions of these countries is increasing. The Kingdom of Saudi Arabia gives great attention to developing and adopting artificial intelligence applications, as the Kingdom of Saudi Arabia's Vision 2030 included many goals in the field of artificial intelligence that aim to achieve great progress in this field and enhance economic development that depends on its income from various sources by supporting non-oil sectors and industries and developing its society comprehensively. In

many of the goals of the Kingdom's Vision 2030, which amounts to 96 goals, the Kingdom is moving directly and indirectly towards achieving them by relying on artificial intelligence and big data to improve the quality of services provided to its citizens and achieve efficiency and effectiveness in providing them. Despite the continuous technical progress and development of artificial intelligence worldwide, its multiple applications and uses have revealed many increasing challenges and risks that affect multiple aspects of economic, social, cultural and other life. Therefore, this research will analyze and highlight the most prominent challenges and risks in the application and adoption of artificial intelligence applications and understand the aspects of conflict and balance between technical development in artificial intelligence and the economic, social and cultural challenges that may arise from this adoption of artificial intelligence applications, within the framework of the goals of the Kingdom of Saudi Arabia's Vision 2030, and provide appropriate recommendations and suggestions for decision-makers to deal with them with the aim of supporting the Kingdom's efforts in achieving the goals of its ambitious vision in facing the challenges of the digital age and artificial intelligence.

2. Conceptual Framework

A- Artificial Intelligence: With the development of the field of artificial intelligence and the advancement of technology, understanding the term artificial intelligence has become necessary and complex, because the definitions of artificial intelligence have varied widely among researchers, organizations and specialists in this field. This natural diversity in the concept reflects the development witnessed by artificial intelligence and the multiplicity of dimensions and objectives it includes, as well as its intersection with many different specializations that give each specialization its own perspective and definition of artificial intelligence. Despite the importance of artificial intelligence in our current era, there is no unified and agreed-upon definition of artificial intelligence yet, so artificial intelligence is viewed by many as a field more than a concept that can be easily defined1. This variation in definitions reflects the complexity of the concept and its continuous development. Since the scientist John McCarthy introduced it as the science and engineering of making intelligent machines2. A group of definitions have emerged that are consistent with this definition, such as Waterman's definition, which indicates that artificial intelligence is part of computer science that develops intelligent computer programs3. As well as Feigenbaum's definition, which defines artificial intelligence as a field of research aimed at understanding and developing intelligence in machines4. Therefore, this group of definitions presented artificial intelligence in its first form, indicating that it is a science concerned with studying intelligence in machines and programs without referring to the type of this intelligence or how it works or its goals.

In the context of the development of artificial intelligence, its goals and types, another group of definitions emerged that were more focused on simulating human intelligence, as it was defined as an imitation of human capabilities in terms of thinking and behavior and simulating human cognitive processes to a large extent. Artificial intelligence refers to the replication of human intelligence in machines that can think like humans and imitate their behavior5. It is a technology that aims to replicate human intelligence in machines6. Kasemsap defined it as a branch of science that helps machines to find solutions to complex problems in a human-like way 7. While

another group of definitions focused on implementing human tasks to reflect artificial intelligence through its ability to perform functions that were previously the preserve of humans, indicating automation and efficiency in implementing tasks. Therefore, artificial intelligence was defined as the ability of machines to perform tasks and activities that humans used to do8. It is the technology that enables machines to think, understand, and perform tasks that were previously done by humans 9.

On the other hand, several other definitions have focused on the ability of artificial intelligence to think and learn, highlighting the cognitive aspects of artificial intelligence such as thinking, learning, and problem solving. Kaplan and Haenlein define artificial intelligence as the ability of a system to correctly interpret external data, learn from it, and use that knowledge to make decisions10. In another definition, artificial intelligence is defined as the intelligence displayed by machines, which simulates human cognitive functions such as thinking, learning, and problem solving to reflect the concept of artificial intelligence through its ability to perform functions that were previously the exclusive domain of humans, such as perception and execution11.

Through the previous definitions of artificial intelligence, we find a great difference in several aspects, such as narrow and specific definitions versus comprehensive definitions, as some definitions refer within their narrow limits to the simple ability of an intelligent system to solve specific tasks only without thinking outside this context, while comprehensive definitions consider artificial intelligence as a set of comprehensive thinking capabilities such as machine learning, decision-making, understanding languages, and the ability to deal with a variety of tasks and fields. In a different context, the difference between definitions that limit artificial intelligence to limited capabilities and those that describe it as consciousness emerges, as many definitions use the term "consciousness" to refer to the ability of artificial intelligence to deal with the environment in a manner similar to human consciousness, while some other definitions see this as just a simulation of consciousness without possessing real consciousness. Ethical definitions compared to technical definitions also highlight the difference in how artificial intelligence is defined from an ethical perspective compared to technical definitions only, as some definitions take into account social and ethical impacts. For artificial intelligence and how to use it. Our understanding of artificial intelligence through this diversity in its definitions and the disparity between them contributes to shedding light on the importance of this field and its increasing impact in our society today and contributes to directing research and applications in the field of artificial intelligence better according to the needs of society and modern developments. Therefore, the researcher provides a definition of artificial intelligence describing it as a field within computer science that aims to develop machines and software capable of performing tasks, activities, and human cognitive processes that simulate human intelligence, such as thinking, learning, and decision-making.

B- Saudi Arabia's Vision 2030: On April 25, 2016, the Kingdom of Saudi Arabia announced its vision until the year 2030, later known as Vision 2030, which is the Kingdom of Saudi Arabia's plan for the post-oil era and aims to achieve a bright and prosperous future for the Kingdom by diversifying the economy and reducing dependence on oil, strengthening non-oil economic sectors such as tourism, entertainment, and industry, improving the quality of life of citizens and residents, and enabling citizens and companies to achieve their full potential.

Therefore, it aims primarily to enhance the Kingdom's role as a leading economic and cultural power in the Arab and Islamic world, supported by major reforms that include the public sector, economy, and society. The Kingdom's Vision 2030 is built on three main axes, which represent the basis for an integrated strategic plan that includes 96 diverse objectives with the aim of reshaping the Kingdom of Saudi Arabia for the post-oil era.

The first axis, "A Vibrant Society", places at its forefront two main objectives: the first aims to promote Islamic values and national identity, and the second aims to enable the population to achieve a healthy, prosperous and active life. From these two objectives, nine secondary objectives emerge, which in turn include 29 detailed third-level objectives.

The second axis of Vision 2030, "A thriving economy", is based on two essential goals. The first is concerned with stimulating economic development and economic diversification, while the other seeks to raise employment rates. From these two goals, 11 sub-goals of the second level emerge, which include 46 other sub-goals of the third level. In the third axis, "An ambitious nation", it is based on two important goals to achieve Vision 2030. The first revolves around enhancing government effectiveness, while the other aims to enable social responsibility. From this, 7 sub-goals of the third level emerged, which in turn branched into sub-goals of the third level with 21 goals 12.

C- Challenges and risks of artificial intelligence: The concept of challenges and risks of artificial intelligence is concerned with studying and analyzing the potential obstacles and problems that may arise from the development and application of artificial intelligence technologies in various sectors and fields. This concept includes assessing the potential negative impacts on social, economic, ethical, and legal aspects. It also aims to deepen the understanding of how artificial intelligence interacts with human and environmental factors to ensure its development and use in a way that serves the public interest13. The analysis of challenges and risks enables, by developing a framework for critical thinking, the sustainable and responsible integration of artificial intelligence into the fabric of daily life14. The importance of this approach lies in its ability to formulate effective policies and strategies to manage challenges and maximize the benefits of artificial intelligence while minimizing the risks associated with it15. The researcher defines challenges and risks of artificial intelligence as the difficulties and obstacles facing the application, development, and management of artificial intelligence technologies in the public sector, as well as the potential negative effects of this technology on individuals and societies.

3. Study problem:

The main research problem is that despite the strenuous efforts made by the Saudi government to achieve comprehensive and sustainable economic development and enhance the social welfare of citizens through Vision 2030, and since Vision 2030 indicates that 66 of its 96 goals are directly and indirectly linked to artificial intelligence and big data16. However, the challenges and risks associated with artificial intelligence may constitute a major obstacle to achieving these goals, so the study aims to analyze the challenges and risks that may hinder the application of artificial intelligence in achieving the Kingdom's Vision 2030 by answering the following main

research question: What are the main challenges and risks associated with the application of artificial intelligence in achieving the goals of the Kingdom of Saudi Arabia's Vision 2030?

4. The objectives of the study:

The main objective of this study is to understand and analyze the challenges and risks that may face the application of artificial intelligence in the Kingdom of Saudi Arabia and its impact on achieving the Kingdom of Saudi Arabia's Vision 2030, and to develop a proposed model that includes a comprehensive classification of these challenges and risks that aims to provide a reference framework that helps decision-makers and officials understand the main issues and determine the necessary procedures to deal with them effectively.

5. The importance of the study:

The importance of the research is determined by the addition provided by the proposed model in the theoretical scientific aspect as well as in the practical applied aspect alike, due to what it provides in addition to the body of knowledge in a field that is renewed and still considered emerging and under development, especially in the Saudi and Arab context, due to the lack of local and Arab research and studies - to the researcher's knowledge - that addressed the challenges of applying artificial intelligence, while its importance lies in the practical applied aspect by informing decision-makers and stakeholders of the challenges that the application of artificial intelligence may pose to achieving the goals of Vision 2030 and avoiding the potential effects accompanying its use.

6. The study limits:

This research was limited in its objective limits to addressing the challenges and risks facing governments and the public sector due to the use of artificial intelligence, while its time limits were limited to the time period extending from 2018 to 2024, which is the period that witnessed development in the application of artificial intelligence technologies as well as in the research that addressed the research topic.

7. Methodology

The researcher used the descriptive analysis methodology for the challenges and risks of artificial intelligence using the systematic review method of the literature that addressed the challenges and risks of intelligence that governments face, as well as a critical analysis of the secondary data available on the goals of the Kingdom of Saudi Arabia's Vision 2030 and the strategy of artificial intelligence and big data.

A-Data collection stage:

The researcher used the Saudi Digital Library in the data collection process which has many partnerships with the largest global research databases such as ProQuest, Wiley, SAGA Journal, Scopus, Emerald and Google scholar. The researcher also used the following determinants in the research process: Study period: From 2018 to 2024. Research language: English. Article type: peer-reviewed scientific research. Keywords used in the study: Artificial Intelligence, Challenges, Risks, Vision 2030, Kingdom of Saudi Arabia. The inclusion criteria specified studies that directly address the research topic, while the exclusion criteria were specified in the following points: First, studies that are not directly related to the topic of artificial intelligence challenges. Second, studies that only addressed a specific and specific sector of government sectors and lacked comprehensiveness. Third, old studies that do not reflect current challenges or developments in the field of artificial intelligence. Fourth, studies that do not have full access to databases.

During the search process, 23 studies were obtained, which were included in the review, through a number of successive steps: The first step, which is (comprehensive search), resulted in obtaining 2783 peer-reviewed studies. The second step (examination by titles) Through careful examination of the study titles, 112 studies were identified that were directly related to the research topic. The third step (examination by abstract) Through the review and in-depth examination of the study abstract, 51 studies were identified, the rest were excluded due to relevance to the topic, low quality, repetition, inability to access the full content of the studies, or their lack of comprehensiveness and addressing only one aspect or a specific part of the research topic. The fourth step (full examination) During which the full content of the studies was reviewed, resulting in identifying 23 studies to be included in the review, and this is explained in table (1), which includes the titles of the studies translated by the researcher.

Table 1: Studies included in the review

Study title	author	Year
Artificial intelligence for the public sector: opportunities and challenges of cross-sector collaboration[17]	Mikhaylov et al.	2018
Artificial Intelligence and the Public Sector—Applications and Challenges[18]	Wirtz et al.	2018
"Opportunities and challenges for artificial intelligence in India[19]	Kalyanakrishnan et al	2018
Artificial Intelligence in the public sector: a study of challenges and opportunities for Norwegian municipalities[20]	Mikalef et al.	2019
Mapping the Challenges of Artificial Intelligence in the Public Sector: Evidence from Public Healthcare[21]	Sun & Medaglia	2019
Artificial Intelligence in Public Sector[22]	Surya	2019
Comprehensive review on the challenges that impact artificial intelligence applications in the public sector[23]	Mutawa & Rashid	2020
"Chief information officers' perceptions about artificial intelligence: A comparative study of implications and challenges for the public sector[24]	Criado et al.	2020
AI strategy of India: policy framework, adoption challenges and actions for government[25]	Chatterjee	2020
"Addressing the challenges of government service provision with AI[26]	Zheng et al.	2020
Machine learning in governments: Benefits, challenges and future directions[27]	Pi	2021
Artificial intelligence risks and challenges in the Spanish public administration: An exploratory analysis through expert judgements[28]	Sobrino-García	2021
Towards a systematic understanding on the challenges of procuring artificial intelligence in the public sector[29]	McBride et al.	2021
The Implementation of Artificial Intelligence in the Public Sector: Opportunities and Challenges[30]	Seyadi et al.	2021

Digital transformation, artificial intelligence and effective public services: challenges and opportunities[31]	Osborne et al.	2022
Impact of AI Applications in Public Sector Services[32]	Weerasinghe et al.	2022
Artificial Intelligence in Government: Risks and Challenges of Algorithmic Governance in the Administrative State[33]	VidaFernández	2023
THE DARK SIDE OF ARTIFICIAL INTELLIGENCE ON THE BASIS OF PUBLIC ADMINISTRATION[34]	ULAŞAN	2023
Artificial intelligence, task complexity and uncertainty: analyzing the advantages and disadvantages of using algorithms in public service delivery under public administration theories[35]	Nzobonimpa	2023
The Impact of Using Artificial Intelligence on Public Services in Indonesia[36]	Mulyana	2023
Exploring the factors, affordances and constraints outlining the implementation of Artificial Intelligence in public sector organizations[37]	Maragno et al.	2023
Embracing artificial intelligence challenges for public sector organizations in pakistan[38]	Nazir & Gul	2023
Opportunities, challenges, and benefits of AI innovation in government services[39]	Alhosani & Alhashmi	2024

8. Artificial Intelligence in the Kingdom's Vision 2030.

Artificial intelligence is a major driving force for the targeted transformations in the Kingdom's Vision 2030, providing unique opportunities to enhance efficiency and effectiveness in addition to improving the services provided to citizens, thanks to its ability to process and analyze huge amounts of data with unprecedented speeds and accuracy and contribute to decision-making and improving operational processes and developing mechanisms for interacting with citizens, which has made the opportunities of artificial intelligence extend across various fields, providing innovative solutions to various challenges, therefore, the Kingdom of Saudi Arabia is investing heavily in artificial intelligence technologies and their applications within its national strategy for data and artificial intelligence, as well as within Vision 2030 to achieve its goals in various vital sectors such as health, energy, transportation and communications, education and others. For sequence and clarification, we will review the most prominent opportunities, achievements, and goals associated with each sector of these sectors

A- Healthcare sector: The healthcare sector is considered one of the most fields in the public sector that has benefited from the use of artificial intelligence applications, which has revolutionized the quality of health services, enhanced operational efficiency, and achieved better health outcomes for patients, in the field of early diagnosis. Artificial intelligence can analyze medical data, including images and genetic tests, to detect diseases in their early stages, which increases the chances of successful treatment, such as diagnosing skin cancer based on models. Deep learning and neural networks40, 41.

In the Kingdom of Saudi Arabia, Vision 2030 and the National Strategy for Data and Artificial Intelligence aim to align the uses of data and artificial intelligence in healthcare systems with the aim of enhancing access to health services and preventive care, along with accommodating the increasing demand for health services, thus achieving the vision's goals in improving health services, which has enhanced several aspects of health services. For example, the Ministry of Health launched the virtual Seha Hospital service with the activation of the Lunit INSIGHT CXR technology, which relies on artificial intelligence in analyzing chest X-rays, in service of the guests of God during the Hajj season of 1444. Through use of artificial intelligence algorithms, this contributed to predicting diseases that may affect the lungs and heart, which increased the

accuracy of doctors' assessment of the results and gave priority to critical cases that need urgent medical care. The Ministry indicated that the use of artificial intelligence algorithms contributed to predicting diseases that may affect the lungs and heart42.

In the area of drug research and development, artificial intelligence contributes to accelerating the process of discovering and developing new drugs by analyzing biological and chemical data, which reduces costs, time and quality, as well as accelerating the time to market. 43. The achievement of Dr. Ali Hussein Al-Hassan, an academic researcher at King Abdulaziz City for Science and Technology and an associate professor at Al-Faisal University in Riyadh, is one of the most important and distinctive results in this sector, as he was able to develop a new treatment for the hereditary disease of sickle cell anemia using generative artificial intelligence and nanotechnology44.

B-Energy Sector: Artificial intelligence expands the scope to new horizons in the energy and electricity sectors, contributing to enhancing efficiency, supporting sustainability, and ensuring energy security and supplies, thus achieving the vision's goals of maximizing the value generated from the energy sector and developing and diversifying the Saudi economy, as artificial intelligence contributes to improving the expectations of traditional energy production and renewable energy such as solar and wind45 and connecting them and managing supply more efficiently, which improves the stability and efficiency of the electricity grid, making it smarter and more effective, reducing waste and improving energy distribution 46.

One of the most prominent uses of artificial intelligence in this field is the contribution made by ExxonMobil and the Massachusetts Institute of Technology MIT to detect oil leaks using robots powered by artificial intelligence 47. Artificial intelligence in the oil sector also provides many opportunities for improvement in exploration and production operations, as it enhances the efficiency of searching for and extracting oil thanks to the analysis of geophysical data provided to it and improves and enhances the efficiency of oil refining operations and reduces the potential damage to the environmental footprint of these operations. In the context of the last point and to reduce gas emissions, the Kingdom of Saudi Arabia, through Aramco, has presented a distinguished model in designing, developing and operating a gas flaring monitoring program for analyzing, predicting and reducing gas flaring quantities, as this program has contributed to reducing the total gas flaring in flaring by more than 50 percent since 2010, making it the lowest flaring rate in the energy sector in the world48. The Saudi Ministry of Energy, in cooperation with the Saudi Data and Artificial Intelligence Authority (SDAIA), through their joint center (Energy Artificial Intelligence Center) in 2022, sought to sign two agreements to attract artificial intelligence technologies in this sector. The first agreement was with IBM, which aims to accelerate the adoption of a circular carbon economy approach using artificial intelligence, and the second with Siemens Advanta, a global company, to develop artificial intelligence solutions for the electricity and renewable energy sector in the Kingdom, with the aim of enhancing digital transformation to serve the goals of the energy sector and maximize its value within Vision 203049.

C-Transportation and Communications Sector: The Kingdom of Saudi Arabia seeks to achieve its goals in establishing the Kingdom as a global logistics center, where artificial intelligence plays a pivotal role in reshaping the transportation and logistics sectors, as the use of artificial

intelligence enhances the smoothness and effectiveness of transportation and distribution operations, improves customer experience, reduces the environmental impact of the industry, and drives the transformation in the transportation sector through several pioneering technologies such as self-driving vehicles, which are not limited to personal cars only, but extend to include trucks and public transportation, which promises to bring about radical changes in logistics and civil transportation 50. Artificial intelligence has also played an important role in developing smart traffic management systems through use of real-time traffic data and advanced analytics, which enables improving traffic flow, reducing congestion, and improving air quality by directing vehicles more efficiently 51.

While artificial intelligence and its applications have redefined the supply chain and logistics sector through the application of automation and robotics in warehouses, AI-powered robots help organize goods, determine locations, and package them, which speeds up the preparation and shipping process and reduces the possibility of human error. Predictive analytics based on artificial intelligence algorithms, which accurately forecast demand for products, have greatly improved inventory management and reduced storage costs, in addition to improving supply chain planning52.

Artificial intelligence can also improve shipment tracking and fleet management by providing accurate and real-time data on the location of shipments, which helps reduce shipping times and increase transparency with customers. In the Kingdom of Saudi Arabia, Vision 2030 pays great attention to investing in artificial intelligence applications in transportation and communications, as the national strategy for data and artificial intelligence focused on integrating data and artificial intelligence in the transportation sectors with the aim of building a regional logistics center, establishing systems based on the use of smart technologies in transportation, and enhancing traffic safety in cities. This was reflected in the start of adopting artificial intelligence applications in 2022 in partnership between the Ministry of Transport and Logistics and the Saudi Data and Artificial Intelligence Authority with the aim of developing the uses of advanced analytics and artificial intelligence algorithms in a number of areas that include modeling multimodal transportation and predicting future demand, improving the smoothness of transportation and the efficiency of services, enhancing the integration of transportation patterns and supply chains, in addition to behavioral and demographic studies of users of transportation patterns53.

D-Education Sector: Artificial intelligence applications in education represent a revolution in how to learn and teach, providing innovative solutions that address existing challenges and bring about radical transformations in the educational process. These applications redefine the rules of learning and expand the horizons for achieving unique achievements in multiple fields, as artificial intelligence contributes effectively to a radical change in traditional methods of teaching and learning, which enables educational institutions to provide personalized educational experiences that meet the needs and capabilities of each individual student, opening the door to improving the quality of education and expanding job opportunities in this sector. Artificial intelligence also contributes to developing curricula and their content by analyzing students' performance and preferences to provide personalized educational content that suits their levels and interests, which enhances the effectiveness of learning, in addition to enhancing self-

direction by developing educational programs based on artificial intelligence that allow students to learn in their own way, which reduces the need for direct intervention from teachers and opens opportunities for innovative educational courses54.

Therefore, the Kingdom's Vision 2030 worked to achieve many different goals to develop and educate human capital by improving educational outcomes, improving the ranking of educational institutions, and improving equal educational opportunities among members of society. Artificial intelligence applications are one of the most prominent main enablers to achieve these goals.

9. Model of Challenges and Risks of Artificial Intelligence:

A review of the distribution and spatial context of previous studies in Table 1 shows that they cover a variety of different geographical and societal contexts from around the world, as a number of these studies focused on the challenges of artificial intelligence in developed countries such as the United States of America, Norway, Spain, Estonia, the Netherlands, the United Kingdom, and European countries in general, while a number of other studies addressed aspects of the challenges in a number of developing countries such as India, Indonesia, Pakistan, and China, while two other studies focused on countries in the transition phase from developing to developed countries such as Serbia and Mexico, while the rest of the studies addressed the challenges related to artificial intelligence in general without specifying a specific spatial context for them. It is expected that this diversity and wide range of studies will enhance, from the researcher's point of view, the comprehensiveness of the research topic and its analysis, which helps in identifying the most prominent challenges associated with the application of artificial intelligence.

To build a model of the challenges and risks of artificial intelligence facing governments and to analyze and understand these challenges related to the field of artificial intelligence, the researcher followed a sequential methodology based on a comprehensive and organized analysis that aims to provide an in-depth vision on how to deal with the current and future challenges posed by the development of artificial intelligence, by dividing the process into successive and specific steps, as the researcher seeks to build an analytical model that covers the various dimensions and contexts related to artificial intelligence, from basic definitions and classifications to temporal and spatial dimensions as follows:

1- Initial analysis: The researcher aims through it to provide the initial comprehensive analysis in which he aims to limit all the challenges and risks referred to in the 23 studies referred to in Table 1. This step resulted in identifying 45 different challenges to the application of artificial intelligence in the public sector as shown in Table (2).

Table 2: All challenges identified through the Initial analysis phase

Challenges	Reference 17	Reference 18	Reference 19	Reference 20	Reference 21	Reference 22	Reference 23	Reference 24	Reference 25	Reference 26	Reference 27	Reference 28	Reference 29	Reference 30	Reference 31	Reference 32	Reference 33	Reference 34	Reference 35	Reference 36	Reference 37	Reference 38	Reference 39
scarcity of talent	✓	✓	—	✓	✓	✓	—	—	✓	—	—	—	—	✓	—	✓	✓	✓	—	—	✓	—	✓
salary inequality	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓	—	—	—	—

job loss	✓	—	✓	—	✓	—	✓	✓	—	—	—	—	—	✓	—	—	—	✓	—	✓	—	—	—
Infrastructure readiness	✓	—	✓	—	—	✓	✓	✓	✓	—	—	—	—	—	—	—	✓	✓	—	✓	✓	—	—
Research, development and innovation	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓	✓
Big data availability	✓	—	—	—	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	✓	—	—
Public-private joint investment	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyber Security	✓	—	—	—	—	—	✓	✓	—	—	—	—	—	—	✓	—	—	—	✓	—	—	—	—
Privacy	✓	✓	—	—	✓	✓	✓	—	✓	✓	—	✓	✓	—	✓	✓	✓	—	✓	—	—	—	✓
Safety and security	✓	✓	—	✓	✓	—	✓	—	—	—	—	—	—	—	—	—	✓	—	✓	—	—	—	—
Transparency	✓	—	—	—	✓	—	—	—	—	✓	✓	✓	✓	—	—	✓	✓	✓	✓	—	—	—	✓
International competition	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Private sector dominance of investments	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ethical issues	—	✓	—	✓	✓	—	—	—	—	—	—	—	✓	—	✓	—	—	—	✓	—	—	—	—
Research funding	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Market Challenges and Regulatory Environment	✓	—	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Data Quality	—	✓	—	✓	✓	—	✓	✓	—	—	✓	—	—	—	—	✓	—	—	—	—	✓	—	—
Financial capacity	—	✓	—	✓	✓	—	✓	✓	✓	—	✓	—	—	—	—	—	—	—	✓	—	—	✓	—
Trust/Community Acceptance	—	✓	—	—	✓	—	✓	✓	—	—	—	—	—	—	—	✓	—	✓	✓	✓	✓	—	—
Human-machine interaction and machine-machine interaction	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	✓	—	—	—	—	✓	—	—	—
Regulatory legal	—	✓	—	—	—	—	✓	✓	—	—	—	—	—	—	—	—	✓	—	—	—	—	—	—
Accounting/Accountability	—	✓	—	—	✓	—	—	—	—	✓	✓	✓	✓	—	✓	—	✓	—	✓	—	—	—	✓
interpretability of decisions	—	—	—	—	—	—	—	—	—	—	✓	—	—	—	—	—	✓	—	—	—	✓	—	—
bias	—	—	✓	✓	—	—	—	—	—	—	✓	✓	✓	—	✓	—	✓	✓	—	—	—	—	✓
Censorship	—	—	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	✓	✓	—	—	—	—	—
Relying on service providers	—	—	—	—	—	—	—	✓	✓	—	—	—	—	—	—	—	✓	—	—	—	—	—	—
Legal regulatory frameworks	—	—	—	—	✓	—	✓	—	—	—	—	✓	—	—	—	—	—	—	—	—	✓	✓	—
Challenges and bureaucratic structures	—	—	—	—	—	—	—	—	—	✓	—	—	✓	—	—	—	—	—	—	—	✓	✓	—
Lack of awareness and resistance of bureaucrats to change	—	—	✓	✓	✓	✓	—	✓	✓	—	✓	—	—	—	—	✓	—	—	—	—	✓	✓	✓
Lack of strategy	—	—	—	—	✓	—	—	—	—	—	—	—	—	✓	—	—	—	—	—	—	—	—	—
social discrimination	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Operating costs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓	—	—	—
Salary increase	—	—	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓
Training and investment in human resources	—	—	—	—	—	✓	—	—	—	—	—	—	—	✓	—	—	—	—	—	—	—	—	—

Intellectual Property	—	—	—	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓
Governance	—	—	—	✓	✓		✓	—	—	—	—	—	—	—	✓	—	—	—	—	—	—	—	—
Process integration	—	—	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Employment Obstacles	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓
Collaborate with experts and staff	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓
Scalability	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓
Data Ownership	—	—	—	—	—	—	—	—	—	—	—	—	✓	—	—	—	—	—	—	—	—	—	—
social inequality	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	✓	—	—	—	✓	—	—	—	—
Poor skills and training	—	—	—	—	—	—	—	—	—	—	—	—	—	—	✓	—	—	—	—	—	—	—	—
Income inequality	—	—	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

2- Analysis of the most recurring challenges: This step aims to identify the most recurring challenges among the identified studies with the aim of identifying the main issues and most pressing challenges in the field of artificial intelligence. There were 9 different challenges that were repeated in the identified studies more than 9 times, so the challenge related to privacy is the most discussed point in the studies, as it was mentioned and referred to in 14 studies. This challenge includes a set of concerns and difficulties related to protecting individuals' data and personal information from unauthorized use, disclosure, access, unauthorized modification, destruction, or negative exploitation that may harm people and societies. The challenge of scarcity of qualified talents comes as the second largest challenge with a recurrence of 12 times, which is the difficulty associated with finding qualified individuals with the skills necessary to develop, manage, and implement artificial intelligence applications. While the challenge of transparency related to the ability of users and stakeholders to be able to see and understand how artificial intelligence systems work, along with the challenge of lack of awareness and resistance to change among bureaucrats working in public cleaning services of the uses of artificial intelligence applications, came as the third most common challenge, with 11 times. The fourth most frequent challenge, with 10 times, is the challenge of infrastructure readiness for artificial intelligence applications, as well as the challenge of accountability and questioning, which is related to determining responsibility for the results of decisions made by artificial intelligence technologies and which affect people and societies. This is followed, with 9 times, by the challenge of the financial capacity and solvency to implement artificial intelligence, the challenge of trust and community acceptance of these applications, their uses and results, in addition to the challenge of bias, injustice and concerns that accompany the application of artificial intelligence and its impact on people or segments of society.

The researcher attributes the emergence of these challenges more than others in particular to the rapid growth, expansion and continuous development of artificial intelligence applications. This progress requires the availability of sufficient financial resources and advanced infrastructure, as well as the presence of qualified and specialized human talents to manage and operate it, as well as a high level of awareness of the benefits offered by artificial intelligence and the potential negative effects of its use. In addition, the state of uncertainty and clarity of the potential negative effects of the uses of artificial intelligence is a reason for the emergence of issues of transparency, accountability, and ensuring justice and impartiality in the use of these applications.

3- Categorical analysis: The researcher aims through this step to classify the challenges into categories or groups according to their common characteristics, nature, and properties, which helps in organizing the analysis and understanding the challenges in a deeper and clearer way and facilitates the process of building a comprehensive model for the challenges of artificial intelligence. This analysis resulted in 6 different categories: the technical challenges category, the economic challenges category, the socio-cultural challenges category, the legal and ethical challenges category, the organizational challenges category, and finally the political challenges, according to the following criteria:

-Economic challenges: They refer to the set of difficulties and obstacles associated with the economic impact and costs associated with developing, adopting and implementing artificial intelligence, as studies have indicated that securing adequate funding for projects related to artificial intelligence and developing the necessary technical infrastructure to enable the use of artificial intelligence applications represent prominent economic challenges, which may be an obstacle to achieving the projects and goals of Vision 2030 in the Kingdom of Saudi Arabia. In addition to the challenge of the costs of developing skills and providing the necessary training for workers and users to deal with this modern technology. The need for continuous funding for research and development in the field of artificial intelligence is an important and challenging matter to ensure continuous growth and innovation in this sector, while operational costs are also a challenge due to their need for large investments to maintain and operate the technical infrastructure, software, and update systems, etc. The increasing demand for professionals specialized in the field of artificial intelligence, such as data engineers, artificial intelligence developers, and data scientists, may lead to a significant increase in salaries, which may be a challenge to the economic bill and the general budget of the Kingdom of Saudi Arabia. On the other hand, the challenges of the artificial intelligence market and its continuous and rapid changes, in addition to the private sector's significant dominance over it, are another challenge that requires a lot of continuous and large investments to bring these technologies and compete to attract specialized talents to continue using and applying the latest technologies and best practices.

-Social and cultural challenges: These refer to the obstacles and issues related to the effects of artificial intelligence technologies on society and culture, and the changes they can bring to the social fabric and cultural values. Therefore, the challenge of the impact on employment and the concerns associated with the application of artificial intelligence about job loss due to automation and its social impacts emerge. The challenge of social inequality and social disparities is also one of the risks of applying artificial intelligence, which leads to deepening economic and social gaps, especially between individuals and communities with different incomes. In addition, the social acceptance of artificial intelligence applications is one of the obstacles facing its application and the concerns and lack of confidence in its uses that may affect individuals and society. On the other hand, the process of interaction between artificial intelligence and humans is another social challenge, as artificial intelligence is only able to interact with humans in a unified way, making it difficult to deal with humans in a variable way based on different social contexts.

- Legal and ethical challenges: They include all legal aspects and ethical standards that must be taken into account when developing and applying artificial intelligence technologies and require legal guidelines and ethical frameworks. Therefore, building legal frameworks was a major challenge to achieve other challenges such as protecting the privacy of individuals during the use of artificial intelligence that relies on the collection and use of individuals' data. In addition to promoting justice by ensuring that artificial intelligence applications operate in a fair manner and avoid any biases that may exist or result from the use of artificial intelligence. It is also important in ensuring the challenge of transparency and interpretability of any artificial intelligence decisions and the ability to understand them by individuals, users and regulators. While the challenge of accountability and responsibility is important in determining who is responsible for damages or errors that may result from artificial intelligence applications, and how to determine the accountability of the parties concerned in the event of an error or bias. Dealing with issues related to ownership and protection of innovations and works created by artificial intelligence systems, including software, algorithms, and data, is another challenge for the application of artificial intelligence. Finally, oversight is another challenge to ensure compliance with existing legislation and audit and evaluation procedures for artificial intelligence systems.

- Organizational challenges: These are the challenges related to the process of developing and applying artificial intelligence within organizations and their effects on how resources, data, and processes are managed and organized within the organization. One of the most prominent organizational challenges is the traditional bureaucratic organizational structures that may not be flexible enough to adapt to the requirements for applying artificial intelligence. The challenge of the scarcity of specialized talents in artificial intelligence that organizations require to apply artificial intelligence and achieve the great opportunities expected from it in improving efficiency and effectiveness is an obstacle in employing and attracting these talents due to the intense competition. On the other hand, we find that the hesitation and unwillingness of bureaucratic employees to adopt artificial intelligence technologies due to a lack of awareness of their benefits or fear of negative impact on them is one of the challenges that also requires facing another challenge, which is providing appropriate training for employees to enable them to work effectively with artificial intelligence technologies and developing the necessary specialized training programs to build a skilled workforce.

- Policy Challenges: These are the comprehensive decisions, policies and frameworks issued by governments and entities concerned with artificial intelligence that affect the development and use of artificial intelligence. One of the most prominent challenges is the lack of a national strategy for artificial intelligence concerned with developing and implementing a comprehensive and well-thought-out plan to guide the development and application of artificial intelligence technologies within the borders of the state, aiming to achieve the positive aspects of artificial intelligence in improving public services, achieving economic development and other goals. In addition, developing a framework for artificial intelligence governance is a major challenge in order to find the rules, principles, policies and standards that are designed to ensure the development and use of artificial intelligence technology in a responsible, ethical and effective manner.

- Technical challenges: These refer to the specific obstacles and difficulties facing the development, application, operation and management of artificial intelligence applications and technologies. Infrastructure readiness is one of the most prominent technical challenges that require, as artificial intelligence requires advanced infrastructure to develop and apply, including high-speed data transmission networks, high-performance computing devices and very large storage spaces. The availability and quality of data is another challenge, as artificial intelligence relies primarily on data to carry out training operations and improve the performance of models, thus improving outputs. The increasing concerns related to cybersecurity are a technical challenge that requires advanced and continuously developing technologies to keep pace with the increasing cyber threats. In addition to all of this, integration with existing systems and integrating artificial intelligence technologies into current technical and operational environments emerges as a challenge to prevent causing technical problems and major disruptions in operations and services provided.

4- Building a comprehensive model of challenges: Through this final step, the researcher built a comprehensive model of artificial intelligence challenges in the public sector, which includes all the previous categories as well as the most prominent challenges that appeared in the previous steps. With the researcher applying a temporal analytical perspective that clarifies the effects of these challenges either before or after starting to use artificial intelligence technologies as part of an integrated analytical model of artificial intelligence challenges, as shown in table (3).

Table 3: Proposed model for artificial intelligence challenges

Challenge	**Pre-implementation stage Artificial Intelligence**	**Post-implementation stage of artificial intelligence**
Economic Challenges	1-Financial capacity 2- Market challenges 3- Private sector dominance 4- Training and investment in human resources 5- Funding scientific research and innovation	1-Operating costs 2- Market challenges 3- Private sector dominance 4- Training and investment in human resources 5- Funding scientific research and innovation
Social and Cultural Challenges	1-Job Loss 2- Trust and Community Acceptance	1-Trust and social acceptance 2- Social inequality 3- Human-machine interaction 4- Income inequality
Challenges Legal Ethical	1-Transparency 2- Legal Frameworks	1-Accountability and Responsibility 2- Transparency and Interpretability 3- Privacy 4- Oversight 5- Bias and Fairness 6- Intellectual Property and Ownership Data
Challenges Politics	1-Lack of strategy 2- International cooperation	1-Lack of governance framework 2- International cooperation
Organizational Challenges	1-Scarcity of specialized talents 2- Poor skill and training	1-Recruitment Obstacles 2- Challenges of Organizational Structures 3- Lack of Awareness and Resistance to Change 4- Poor Skill and Training
Technical Challenges	1-Infrastructure Readiness 2- Data Availability and Quality 3- Systems Integration	1-Cyber Security 2- Systems Integration 3- Scalability

Although the proposed model clearly presents six different categories of challenges, with each category including two challenges that differ according to the time context, whether before or after the implementation of artificial intelligence, these challenges are still significantly intertwined and intersecting, reflecting the complex nature of the issues that governments face

when implementing artificial intelligence. The readiness of the technical infrastructure, as one of the most prominent technical challenges, depends heavily on the economic strength of the country and its financial ability to develop the technical capabilities and infrastructure needed to manage and maintain artificial intelligence applications. While cybersecurity challenges no longer only affect the infrastructure and technical capabilities, they may lead to privacy breaches and leakage of citizens' data, which directly affects the social and cultural challenges through their impact on the confidence of individuals and the public in artificial intelligence and its acceptance in society. Social and cultural challenges also overlap with economic challenges. For example, fear of job losses can hinder investment in artificial intelligence, while adequate funding can help develop training and awareness programs to reduce this impact.

On the other hand, the organizational challenges, especially those related to the restructuring of government bodies to adapt to artificial intelligence and the broad transformations expected as a result, also require attention, as all these aspects overlap and highlight the need for effective economic solutions to deal with them. The lack of equal availability of infrastructure for all citizens and in all different regions can contribute to deepening social and economic gaps, leading to major challenges related to social discrimination and injustice, which means that individuals and communities that do not have access to advanced technology and high-speed internet, for example, may find themselves excluded from the benefits that this technology can provide, such as economic opportunities, education, health care, and e-government services. Therefore, technical challenges may lead to other social, ethical, and legal challenges. Given the importance of data quality and availability in developing artificial intelligence applications as one of the main technical challenges, the absence of reliable and bias-free data in artificial intelligence algorithms can lead to biased conclusions, which in turn may reinforce social inequality between different segments of society.

Therefore, the proposed model for AI challenges should be viewed as an integrated structure, as addressing specific challenges alone is not sufficient, given the impact of solutions to a particular challenge on the rest of the challenges. Therefore, it is necessary to adopt a multidisciplinary approach characterized by cooperation between different sectors to innovate comprehensive and lasting solutions, which can fully benefit from the potential provided by AI technology, and thus achieve the goals of the Kingdom of Saudi Arabia's Vision 2030.

10. Discussion

The heavy reliance on artificial intelligence technologies plays a crucial role in achieving the goals of the Kingdom of Saudi Arabia's Vision 2030. It appears that 69% of the total 96 goals set within the vision depend directly or indirectly on artificial intelligence and big data analysis, which poses a significant challenge in the path to achieving this vision. Moreover, the challenges related to the application and use of artificial intelligence in the public sector and government institutions, as identified in previous studies, emerge as obstacles that may prevent achieving these goals.

Without going into the details of each goal of the Vision 2030, the inability to exploit artificial intelligence technologies effectively and responsibly may significantly hinder the achievement

of these goals and thus the achievement of the vision as a whole. On the other hand, the use of these technologies to achieve some specific goals may disrupt or hinder the achievement of other goals within the vision. For example, overcoming the challenge of developing and improving the technical infrastructure can enhance and contribute to achieving many objectives such as the digital economy, building economic cities and improving government services. But this must be done in a way that takes into account justice, prevents social discrimination and avoids disrupting the goal of promoting the values of justice and transparency. On the other hand, potential strategies for increasing employment must also address the need to train the workforce on new technologies to ensure that they benefit from future opportunities.

Using artificial intelligence in healthcare to achieve the goals of raising the quality of health services can contribute to improving health services and facilitating access to them. However, there must be guarantees in using diverse data to train these systems to avoid biases that lead to inequality in the quality of care. On the other hand, it is necessary to ensure the privacy of patient data and prevent its leakage, as well as address issues related to accountability in the event of any problems that may hinder the goals of quality of life and enable a full and healthy life for citizens and residents. On the other hand, advanced technologies such as automatic monitoring and control systems can contribute to enhancing traffic safety, which relies primarily on artificial intelligence technologies. However, it must be ensured that these systems are distributed equally in all cities and regions, in order to also contribute to the goal of improving the quality of life in Saudi cities.

One of the most pressing challenges that could face the realization of Saudi Arabia's Vision 2030 is the impact of artificial intelligence on the labor market, specifically with regard to unemployment and job loss, as automation and smart systems being developed could reduce the need for human labor in some sectors, causing a major shift in the nature of available jobs and the skills required for them. This shift could have mixed effects. On the one hand, it could lead to increased efficiency and the creation of new job opportunities in advanced technology sectors, which would enhance the strategic goals of Vision 2030 aimed at stimulating the economy, development and innovation. On the other hand, it could lead to the loss of traditional jobs, which would put pressure on the Saudi economy. This could require redirecting labor to new sectors by developing sectors that can absorb labor affected by the changes or by supporting new job opportunities through incentives provided to emerging and private companies.

Therefore, given the enormous complexities and overlap between the goals of the Kingdom's Vision 2030 and the challenges of artificial intelligence, it is necessary to take a serious and more deeply thoughtful approach. Harmonious and comprehensive strategies must be developed that are aware of these risks and can benefit from the opportunities available for artificial intelligence applications. This calls for intensive cooperation between government and private agencies and organizations, as well as non-profit civil organizations and citizens, to enhance the position of the Kingdom of Saudi Arabia in progressing towards achieving the aspirations of Vision 2030 in a way that benefits from the capabilities of artificial intelligence and reduces its risks, leading to sustainable development that serves everyone and benefits the entire society.

11. Recommendations

Through the previous review and the way to confront the challenges of artificial intelligence and to achieve the ambitious goals of the Kingdom's Vision 2030, the researcher recommends the following points that would achieve this:

A- Reformulating comprehensive national strategies for artificial intelligence that include all sectors and address how to benefit from artificial intelligence to enhance economic and social development and to avoid the challenges of artificial intelligence identified in the proposed model.

B- Encouraging cooperation and integration between government and private sectors and academic institutions to exchange expertise and resources and develop innovative solutions that support the responsible application of artificial intelligence and reduce its risks.

C- Developing systems to assess and control risks to ensure the safe and ethical use of artificial intelligence technologies within government sectors, in addition to developing mechanisms to deal with the potential social and economic impact of automation.

D- Updating legislative frameworks and laws to reflect new technological developments and providing an appropriate legal environment that protects intellectual property rights, ensures data privacy, and facilitates the process of research, development, and innovation.

C- Launching national educational and awareness training programs focusing on artificial intelligence and digital skills to qualify national cadres and prepare for future work requirements, and to raise awareness of the risks and challenges of using artificial intelligence. H- Encouraging scientific research and innovation in the field of artificial intelligence and encouraging partnerships between universities, the industrial sector and society to develop new technologies, study the challenges of artificial intelligence, and find appropriate solutions.

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