

## DEVELOPMENT OF ARTIFICIAL INTELLIGENCE TECHNIQUES IN SAUDI ARABIA: THE IMPACT ON COVID-19 PANDEMIC. LITERATURE REVIEW

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### Abstract

Artificial intelligence (AI) has already changed the world and has made an effective impact in a range of fields including industry, criminal law, health, national security, transport, nanotechnology, intelligent cities as well as issues such as algorithms and access to the data. In addition, by 2030 it will contribute to the GDP. By being a global technological centre, Saudi Arabia diversifies its economy. Based on its 'Vision 2030' initiative, it has launched the Kingdom's greatest and most aspirant change plan. This paper demonstrated the developed AI techniques of Saudi Arabia that are split into two types. The first type is the NEOM Project, which is a planned city that will incorporate smart city technologies in the northwest of the kingdom, located in Tabuk, Saudi Arabia. The second type is robots, which are machines that can automatically perform a complex series of actions, especially one that is programmable by a computer like SOPHIA Robot, SARAH CHATBOT Robot, Medical Robot, etc. As well as the paper also described the universal efforts of AI to face the pandemic of COVID-19. In addition, the paper outlined how AI techniques could help reduce the burden on health workers to provide faster diagnostic tests and forecast the epidemic's impending outbreak. Finally, the strategies of Saudi Arabia to face the pandemic of COVID-19 have been illustrated.

Keywords: Artificial intelligence techniques, COVID-19, Saudi Arabia.

## 1. Introduction

Although the concept of Artificial Intelligence (AI) has long existed, many researchers believe that it is time for AI to be a reality. Computer science refers to AI research as a "Smart Agents" study: any system which sees and acts in a way that maximizes its opportunities to meet its goals [1]. In 1950, Claude Shannon proposed the concept of computers playing chess. In the early 1960s, AI began. Marvin Minsky believed "the problem of AI simulation is going to be solved within a decade". The first AI applications were introduced during that period. As well as [2] discussed various ideas on humanoid robots were put into practice in antiquity Greek times. Daedelus, who controlled wind mythology and tried to create artificial people, is an example. Modern AI has begun to be used in history to explain the philosopher's model of human thinking. However, Using AI not only engaged with engineering, information technology, finance, and accounting, medicinal, marketing, agriculture, human resource management, law, education, sciences of space, customer services but also contribute greatly to the performance of tasks effectively [3]. Many studies have been carried out to overcome The AI issue, particularly the issue of AI applications. Details of previous studies and their key findings are reported in Table 1.

**Table 1. Studies for AI applications.**

Ref.	Year	Objectives	Key Findings
[4]	2020	Medicine and healthcare	A study presented which suggested methods for prevention, and battle COVID-19 and other pandemics. The role of AI has been checked.
[5]	2020	Medicine and healthcare	Some Deep Learning techniques have been shown to accelerate the process of diagnosis and treatment of COVID-19 disease is the main benefit of these AI-based platforms.
[6]	2020	Medicine and healthcare	Clinical and diagnostic applications for AI have been investigated in dental and maxillofacial radiology.
[7]	2019	Energy and Gas	To analyse and forecast energy markets, a new AI and data-driven predictive model has been developed and tested for Saudi Arabia's gasoline demand. Using real historical market data, the model was designed, trained, validated, and tested successfully.
[8]	2018	Weather and climate condition	In the context of the determination of the specific times in which the rapidly changing average temperature and recapitulation in Greece in the period 1996-2015 are identical to the values of the neighbouring countries, Fuzzy Cognitive Maps (FCM) were used.
[9]	2018	Logistic services	A comprehensive case study on automated truck driving in logistics provided to test the concept concerning practical consequences. The results include the concept of four distinctive and increasing levels of resistance.

Kingdom of Saudi Arabia is taking broad and serious steps to harness all technologies in various fields, especially after the announcement of a vision 2030, which one of its biggest goals is the transition to digitalization. Therefore, it considers AI an important strategic option to achieve this goal, as well as its ambition to hold a high distinguished position among the world's nations. Moreover, the paper shows Saudi Arabia efforts in developing AI techniques and what it intends to achieve. The paper focus on the different Saudi efforts on applying AI techniques in the different field specially in education and healthcare fields. It shows how Saudi Arabia has contributed by AI techniques to facilitating the performance of daily indispensable work, such as holding E-Learning, performing remote work, and even serving people who need medical information about Coronavirus. In addition, using robots and smart pharmacies and some applications that have been used such as TABAOD and TAWAKKALNA.

## 2. What is AI?

Much research defined AI in varies ways. The ability of a system to interpret external data accurately, learn about it and use it to achieve specific objectives and tasks through various changes is one of the most common meanings of AI's concepts [1]. Another definition, AI is an analytical computer assisted course that seeks to shape automated systems which could be referred to as smart systems [10]. Moreover, [10] defined AI as the machine-shaped human intelligence. AI is an attempt to create smart entities which can equal or surpass human intelligence and rationality [11]. "The science of making machinery does what, if done by men, would necessitate intelligence [12]. John McCarthy say that logical reasoning is a "standard" more influential than human capacity to quantify intelligence [13]. This approach to AI uses mathematical logic approaches to officialise the complex tasks artificial intelligence machines perform

## 3. The characteristics of AI

According to [14], the most important characteristics for AI are:

- **Deep Learning:** A machinery that teaches computers to learn by example what naturally happens to humans. There are many areas of AI technology, such as autonomous vehicles, computer vision, automatic text generation, and the like, where deep learning is increasing in scope and use.
- **Facial Recognition:** Facial recognition enabled individual faces to be recognized by means of biometric mapping. The progress made in surveillance technologies has been path breaking. The knowledge is compared to a database of known faces to find a match.
- **Automate Simple and Repetitive Tasks:** Without breaking a sweat, AI could do the same work repeatedly. For example, Siri, an Apple Inc. voice assistant. In a single day, it can handle so many orders. Automation would not only increase efficiencies but would also lead to lower overhead costs and a safer working environment in some circumstances.
- **Data Ingestion:** Data ingestion means that knowledge is transported from different sources to a data storage medium where a company frequently accesses, uses, and analyses it. AI analyses a large number of these data with the help of neural networks and contributes to a logical conclusion from it.

- **Chatbots:** Chatbots are software that provides a window with either audio or textual input to solve customer problems. Before bots, only certain commands were used to respond. It did not know what you meant if you said the wrong thing. Now when you are talking to the chatbot you do not have to be ridiculously specific. It knows not just commands but language. The chatbots not only provide services focused on problems faced by customers, but also provide users with product suggestions. That is all due to AI alone.
- **Quantum Computing:** The field focuses on the creation of quantum algorithms for computer-based work within AI, such as machine learning. It is an interdisciplinary field.
- **Cloud Computing:** Data storage would have been a serious problem if such a large number of information had been channelled every day. Capabilities AI's work in the cloud-based enterprises to make organizations more efficient, strategic, and insight-oriented.

#### **4. Applying AI Techniques**

The positive impact of AI reaches almost every dimension of human life. AI was applied for several models, forecasts, and decision support and control systems in such diverse fields as engineering, economics, linguistics, law, manufacturing, and medicine [14, 15]. The following are examples for how AI techniques are taking part in different fields of life:

##### **4.1. Applying AI techniques in finance filed**

The financial services industry includes AI for massive processing of data, trading, online communication with clients and performing a variety of other essential functions. Another researcher [16] carried out a study to search for AI's effect on the real world, on finance, which has been of significant benefit to many financial sectors from the implementation of AI applications. He concluded that AI technology would increase efficiencies, lower costs, enhance efficiency, boost customer satisfaction levels, and encourage financial inclusion in the provision of financial services. There is many research which presented the benefits of using AI in finance [17-20].

##### **4.2. Applying AI techniques in human resource filed**

Another researcher [3] explained that although the effectiveness of using AI in Human Resource (HR) practice, most organizations continue to be lagging in integrating AI with HR practices due to their integration costs or are afraid that some business processes may be handled by a non-human entity. Moreover, other researchers presented how AI is effective tool in HR [21, 22].

##### **4.3. Applying AI techniques in civil engineering filed**

In the field of adaptive civil engineering systems, [23] have made progress. In an active tensegrity system control setting, self-diagnosis, multi-target type management and enhancement learning processes have been introduced. It is Specifically suitable for modelling complex systems with known input-output data sets among AI computer technologies. The modelling of cement-based materials can be efficient, non-linear, complex, and unambiguous using single, dual, or multiple damage factors. Many other researchers made development in that field [24-27].

#### 4.4. Applying AI techniques in healthcare filed

AI is already used effectively in the field of health care, ranging from online appointments planning to online checks, follow-up appointments call for reminders, diagnosis of the aid for diseases, assistance with procedures of surgery, radiation treatment and offering mental health therapy [28, 29]. Japan has the leadership in using of AI technology in health care. It has already introduced AI robots helping geriatric people to workday by day, from taking morning pills to adjusting the AC temperature during bedtime. It is also useful in the diagnosis of Glaucoma [30].

In China, a primary method for early diagnosis of COVID-19 was AI-powered CT scanning of the lungs, reducing the time spent on diagnosing a case from 30 minutes to seconds. The branch that has been the most up-to-date and welcoming to the use of new technology in clinical imaging and storage is radiology. By identifying rapid negative tests in computed tomography, X-rays, magnetic resonance imaging, particularly in high volume settings, and in hospitals with less available human resources, AI could provide substantial support in radiology [28]. Currently, three South Korean medical institutions, Gachon University Gil Medical Centre, Pusan National University Hospital and Konyang University Hospital, have introduced IBM's Watson for Oncology artificial intelligence system that can identify, evaluate, and compare treatment options by understanding the medical record and applying its training to each individual patient [31].

#### 4.5. Applying AI techniques in marketing filed

Giri et al. [1], showed that implementing AI is useful for future marketing strategy growth. AI is a tool for digital marketers to inspire them and tricks you to get the brand or an individual or group of people to learn it and make it high. It is fair to assume that AI is a secure investment that earns dividends [32]. To convert digital systems into all sectors that contribute to technological progress that will help in economic development, AI technology is a goal for Saudi Arabia during the current period of its [33] initiative to be one of the leading countries in Middle East in implementing and investing of AI applications for the sake of society and individuals [34].

#### 4.6. AI techniques in wastewater treatment field

There are many studies covered the effective role of the importance of technological advancement such as AI techniques in the chemical analysis and wastewater treatment. Khan et al. stated in their study the importance of AI technologies in treatment processes of the effluent discharge from hospitals that has an eminent quantity of chemical waste [35]. Khan et al. covered some aspects of the worldwide disposal and regulatory standard for hospital effluent discharge, its managements and treatment technologies that are widely implemented and perfectly suited [36]. To treat 10m<sup>3</sup>/day of hospital wastewater, a pilot scale CW system was used. The system was tested for 3 months to assess its efficiency in wastewater removal. With all removal efficiency 94% (COD), MLSS (97%), TSS (98%), BOD5 (96%), Phosphate (98%), HSFCW coupled with a tube settler (79 %) [37].

#### 4.7. AI techniques in nanotechnology field

Khan discussed the fact that since the 1994 development of nanotechnology, developed countries have sought the use of modern technologies in all fields, including water purification, in their study entitled "Water and Wastewater Treatment using nanotechnology [38]. "There were positive results compared to other water treatment techniques because of their high surface area (super face/volume ratio), metal containing nanoparticles, carbonaceous nanomaterials, zeolites and dendrimers and nanofibers. In their paper, [39] discussed a few recently used nanomaterials that are currently used in water treatment, with an emphasis on nano-based adsorbents and filtration membranes.

## 5. Scope of AI in the Middle East Beyond 2030

The scope will almost certainly increase after 2030, when AI affects the economy and society. The complexity of AI would almost certainly grow both in the economy and in society. Therefore, to provide a springboard for the future it is necessary for the Middle East to be strategically positioned. The most significant gains, which are equivalent to 12.4% of GDP, are expected, in absolute terms. AI in Saudi Arabia is contributing over USD 135,2,2 billion to the economy by 2030. The UAE is projected to have a significant effect in comparison with approximately 14% of GDP in 2030. As well as the expected annual contribution growth for Bahrain, Kuwait, Oman, and Qatar is 14% of GDP [40].

## 6. Contribution of AI to Gross Domestic Product (GDP) By 2030

The International Data Corporation (IDC) analysis estimates that the Middle East and Africa (MEA), cognitive and AI system expenditure will grow from 37,5 million dollars in 2017 to over 100 million dollars in 2021, which is a 32 % increase yearly. As shown in Fig. 1, strong commitment was shown by the UAE, Saudi Arabia, and Qatar to develop and implement AI technology. So, businesses have invested in new technology strongly, which governments support as early technology consumers. Nevertheless, growth was slower outside the Gulf economies [40].

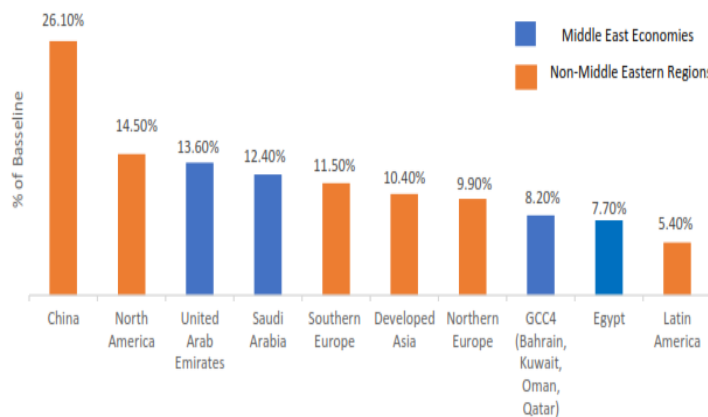


Fig. 1. AI contribution to GDP by Region, 2030.

## 7. The Development of AI Techniques in The Developed Countries

Innovative intelligent manufacturing strategies and policies have been formulated by developed countries, such as the United States and Germany, using AI, such as the Advanced Manufacturing Partnership Plan (2011) and the Industrial Internet (2012) in the United States and the Industry 4.0 Plan (2013) in Germany. The 'Industrial Internet' was adopted by the U.S., which can intelligently analyse intelligent equipment, employees, and data in an intelligent way to make smarter decisions possible. This achieved such a good result. Significant results have been achieved by CPS-based smart manufacturing technology in Germany, e.g., in Germany the Amberg plant is a smart plant model of the Siemens company.

The real factory is run together with the virtual factory at Amberg, and the real factory data and production environments are reflected by the virtual factory through which individuals can manage and control the real factory. Almost 75% of the manufacturing operations have been automated. In robotics, autonomous vehicles, and quantum computing, Germany also has leadership [41].

Chinese scholars have built various types of AI models in China to predict the consumption of petroleum. The large amount of data in the financial market could be used for analysis by artificial intelligent algorithms [42]. According to an online survey of students conducted at Canadian medical schools, as well as in Canada, they expect to add AI to the curriculum as a complement to radiology [43].

## 8. "2030" Vision of Saudi Arabia and National Transformation Program 2020

A strong future vision of advancement of AI-based technology is presented by Saudi Arabia. Vision 2030 for Saudi Arabia and the NTP 2020 recognize digital transformation as a key goal for stimulating the economic sector, supporting businesses and private-sector companies, fostering the development of public-private modelling, and eventually reducing the country's oil-revenue dependence by diversifying the economy [40].

## 9. The Development of AI Techniques in Saudi Arabia

Global AI revenues are projected to increase to \$90 billion by 2025, increasing by an average of 45 percent per year [44]. In addition, AI will contribute to the equivalent of an additional \$15.7 trillion is leading to a 14 percent growth in global GDP by 2030 [40].

Saudi Arabia invested approximately 28 billion dollars in AI in 2017 and 28 new agencies were established in the same year. Furthermore, 128 institutions, like the major countries around the world like China, have been established in this promising field full of opportunity that generates great benefits [45]. Table 2 demonstrates Saudi Arabia's most advanced AI industry techniques.

**Table 2. Saudi Arabia's AI applications.**

Project Name	Description
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NEOM Project	"NEOM" project represents one of the Saudi projects that are being fully established according to the techniques of AI. The project aims to seamlessly integrate robotics and AI in every aspect of the lives of citizens to generate income from major future economic sectors [11, 34]. This intelligent city covering 26,000 Km <sup>2</sup> and cost about \$ 500 billion [45, 46].
SOPHIA Robot	A humanoid robot 'SOPHIA' created by former Disney Imagineer David Hanson. He is an American mechatronic engineer and founder of Hanson Robotics. The robot was designed to emulate social behaviours and as a future of AI [47, 48]. In 2017, the government of Saudi Arabia has awarded citizenship to the robot as a symbolic gesture to the future of the NEOM City project. The announcement of the robot «SOPHIA» that she obtained Saudi citizenship was not the maximum that could be achieved, but rather a step on a long road [45].
SARAH Chatbot Robot	Automatic chat robots or (chatbot) that process responses automatically to people. The Food and Drug Authority has used chatbot to provide a new service called Sarah chatbot that performs automatic responses via the WhatsApp application [45].
TEQANI Robot	It is the first robot employed in the Ministry of Education in 2018, It serves clients and delivers messages to visitors of the exhibitions and activities of the technical and vocational training corporation. It is also the first robot to receive a civil servant card in the government sector [49].
Medical Robot	It is a robot created by Al-Muammar Information Systems Company "MIS". The idea of this robot created during the Hajj season of the year 1440 H, and it had many contributions in dealing with emergency cases that pilgrims were exposed to in places far from doctors [50].
Smart Pharmacy Robot	In 2018 Saudi Arabia opened the first "smart pharmacy" in the Middle East at King Fahd Specialist Hospital in Tabuk. It is run by a fully automatic robot. The pharmacy can distribute and sell more than 1500 bottles of medicine in just one hour. It can also store more than 20 thousand bottles of medicine per day, as well as an expired rejection of them. In addition to the above, the smart pharmacy can read and process 240 prescriptions per hour, which helps to save patients and pharmacists time considerably, and ensures that no errors occur during the process of obtaining the medicine [50].
Nala application Robot	It is the first application in the KSA to provide health care services based on AI technologies in the Arabic language. It was developed in 2019. It allows the answers provision for medical questions, helps to book appointments, and makes simple recommendations based on the information the person entered [50].
SAIR Robot	It is a magnetic robot has been manufactured by Saudi Aramco, which a number of young employees- under the age of 25- worked on developing it. This robot can sense the leakage of dangerous and flammable gases, and detect cracks and corrosion in steel, especially in hard-to-reach places. It is worth noting that the SAIR robot, whose patent was owned by Saudi Aramco, was the first robotics project to be designed and manufactured entirely within the company and to be recognized internationally [49].

## 10. Universal AI Efforts to Face Coronavirus COVID-19



Medical image processing, which has recently appeared in several coronavirus research studies, has been using AI techniques as a fundamental function for COVID-19 detection [51]. For other uses of the DL in medical image analysis, it is recognized from these studies that X-ray images and computed tomography (CT) scans are commonly used to automatically detect the infected case of COVID-19 as a DL model input. A deep convolutional neural network (CNN) model was developed for the detection of COVID-19 cases in [44]. The proposed CNN model can achieve an accuracy of 93.3 percent by practicing 13,975 images of 13,870 patients on an open-source dataset. Many researchers [52-57], considered the use of ML and DL techniques for COVID-19 detection with chest CT scans. These works show high performance as they can achieve a high classification accuracy, e.g., 99.68% in [54], an area under curve (AUC) score of 0.994 in [56], AUC of 0.996 in [54], and 82.9% accuracy (98.27%) with 80.5% accuracy (97.60%) and 84% sensitivity (98.93%) in [56, 57].

### **10.1. Apple and Google team up to "contact trace" COVID-19**

Apple and Google have been creating mobile applications that tell users whether they are linked to someone who has recently been infected. The group plans to team up in a few months to deliver the product, which is built into billions of iPhones and Android devices worldwide. That would permit smartphones to log in to other devices they come near, enabling the so-called touch tracking of the disease, and these have succeeded in areas such as South Korea, where mass virus tests have been carried out [58].

### **10.2. Speeding up drug discovery and development**

AI can enable new drugs and vaccines to be detected, develop, and measured faster than ever. For instance, Insilco Medicine, a portfolio company of Longevity Vision Fund, was able to use its AI techniques for successfully recognizing thousands of molecules in just four days for possible medications. Insilco Medicine then launched an open policy and published the updated results on its website to allow all researchers to download the data free of charge, ultimately contributing to the global fight against the epidemic [59].

### **10.3. Reducing fatality and optimize disease management**

Applying AI techniques can help in controlling the epidemic and reduce deaths by reducing the burden on healthcare workers and by reminding patients of correct treatment procedures. Medical care staff members are at high risk of exposure and contraction to Covid-19. Until now, Covid-19 has infected thousands of medical care staff members in China as well as many other countries. AI can help to alleviate the burden. For instance, China uses robots to provide faster diagnostic tests. Also, AI assists Hangzhou City Ambulances to speed up traffic. Moreover, AI can also help people to better understand what their reactions should be in case they affected with the virus. China has released an App that lets people verify whether a confirmed COVID-19 patient has taken a flight or a train. Moreover, it is using drones to ensure adequate measures are taken by the residents [59].

### **10.4. Forecasting epidemics**

Applying AI techniques can alert from an impending outbreak and give people ample time to plan for it. To evaluate information from a variety of sources and monitor over a hundred infectious diseases, BlueDot, a global AI software company, uses AI-powered algorithms, machine learning, and natural language processing. In the coming days, it is expected that AI could even use social media data to predict human actions and possible outbreaks [59].

## **11. How Saudi Arabia Employed AI Techniques Against the COVID-19 pandemic**

As the outbreak of COVID-19 began to develop, the government of Saudi Arabia introduced several policy emergencies, including social distance, city lockdown, suspension of activities by several government departments, prohibition of social meetings, individual quarantine, closure of all malls and markets. During the COVID-19 outbreak, the use of modern technologies showed a positive attitude, such as enabling many entities to operate online, and allowing staff to be available at anytime and anywhere. Despite the university's preparation and arrangements, and the great efforts of the stakeholders, there were few challenges, such as engaging and controlling students in classes. The main objective of adopting the transition process to the teaching and model of homework was to minimize the risk of infection with COVID-19, and it was successfully implemented [60]. Moreover, Saudi Arabia developed and applied AI technologies in many different sectors rather than education to solve the bad effects of COVID-19 pandemic. Some of these technologies are:

### **11.1. Doctor B2 robot**

Saudi Arabia has launched a robot at King Salman Hospital in Riyadh that named Doctor B2. The mission of this robot is to communicate with patients in the hospital's isolation rooms. The robot is supported by cameras that monitor patients with COVID-19. The machine was equipped with technology to read vital signs to patients [61].

### **11.2. TAWAKKALNA application**

This application is lanced by Saudi Data and Artificial Intelligence Authority (SDAIA). As well as approved by the Ministry of Health. The aim of this application is to enable government and private entities excluded from the decision to prevent roaming from issuing permits electronically to their employees through a platform for government agencies, and another for the private sector. The application allows obtaining direct licenses for all those whose circumstances require movement during the curfew period, as well as to people who have health appointments. Moreover, it gives permission for delivery delegates to facilitate their movement during Blocking times. TAWAKKALNA application also provides real-time and direct information about number of virus infections in Saudi Arabia and providing the latest alerts and medical news issued by the Ministry of Health about the virus and its spread, and ways to prevent it. A newly added feature for TAWAKKALNA application that it gives walking permissions for individuals. Walking permission is valid for just one hour within one kilometre from home. Registration for the App is available for individuals, citizens, and residents for free [62].

### **11.3. TABAOD application**

This application is launched by Saudi Data and Artificial Intelligence Authority (SDAIA). It is approved to notify users in the event of contact with a person who has been confirmed to be infected with the Corona virus during the past 14 days. The software is available for both citizens and residents. The Ministry of Health has adopted health standards on which the (spacing) application was developed according to the health system and its implementing regulations in the Saudi Arabia and the characteristics and functions of this application will be subject to any additional instructions issued to enforce the regulations and provisions in the Kingdom [62].

### **11.4. E-Learning in schools and universities**

Saudi education ministry released a notice to suspend face-to-face teaching and learning and to temporarily close all educational institutions and use virtual and distance learning classes activated by the platform for online education instead. A variety of reports in Saudi Arabia have addressed e-learning problems. The Department of Jubail Industrial College (JIC) in Saudi Arabia conducted a survey for Management and Information Technology (MIT) teachers. The research results showed a positive opinion for e-learning for most teachers. The results were due to e-learning benefits such as: flexibility and entertainment comfort, saving time, diverse characteristics, etc. [63]. Another study was conducted in King Faisal University in Saudi Arabia as well as six universities in Jordan as multiple cases. The objective of the study is to address the key issues facing current e-learning systems and address the key factors promoting the use of the e-learning system during COVID-19 [64]. Another Study at Qassim University, Saudi Arabia, have taken place. Feedbacks from both faculty members and students have been observed. The results showed that while distance learning has advantages, there are also certain constraints that should be studied [65]. As well as [60] presented how King Khalid University (KKU) handled (COVID-19). The study carried out in the College of Pharmacy, King Khalid University (KKU), Abha, Saudi Arabia. The study illustrated that (KKU) has adopted an online learning method. Online education is managed through the Blackboard learning-management. The results showed that in an emergency, the educational system was already prepared for the switch to web-based education. The participants agreed this mode of education is more flexible than traditional classes, an effective communication tools on online platforms, reliability. They Informed that no difficulties they have faced.

## **12. The Effects of Using Smart Technologies and Robots on Users in Saudi Arabia**

Abdullah examined the perceptions and attitudes of health care workers towards AI technologies in Saudi Arabia's health care institutions [66]. The findings showed that 3.11 of 4 respondents feared that workers would be replaced by AI and had a general lack of awareness about AI technology. Another study conducted by [67] investigated the probability of mobile learning acceptance (m-Learning) and examines the key factors that influence the use of m-Learning in Saudi Arabia for higher education students. The investigator used a sample of 80 students with a quantitative approach. The modified acceptance framework is implemented based

on the Unified Theory of Acceptance and Use of Technology (UTAUT) model to specify the factors affecting the intention of the students to use m-Learning. T

he statistical analysis findings indicate that the acceptance level of m-Learning students is at a high level. Almaleki examined Saudi students' understanding of AI use in EFL learning, and how perception influences their acceptance of AI in EFL learning [68]. Perception was broken down into several independent variables that included facilitating conditions, performance expectancy, social influence, and effort expectancy while the level of AI use in EFL learning was the dependent variable. The received performance expectancy score, social influence score, and facilitating conditions score was 4 of 6, while the score of effort expectancy was 5 of 6. It was also noted that the response to the facilitation of conditions for the use of AI in EFL varied by gender.

### **13. Conclusion**

The speed, that AI is being implemented across different fields will surely trigger the revolution that will be aligned with the aspirations of Saudi Arabia's vision 2030. AI technology takes over most of the positions in the workplaces, factories, and even hospitals in Saudi Arabia. It will increase productivity, enhance decision-making processes across all sectors, provide Saudi people with more innovative services, and open new horizons to promote entrepreneurship.

Digitization and AI are critical drivers of these wide-ranging reforms. The educational reform is the most crucial step undertaking in these initiatives, beginning with digital skills introduction in K-12 education to satisfy changing workplace demands, the education ministry working on those schools and universities to fulfil the need of the future, developing expertise in the areas of AI, data science, data security, etc. This is important to prepare for future jobs for the next generation.

Health care systems in Saudi Arabia recently begun to depend on AI applications, because they can store and addressing tremendous patient data, improving the quality of medical care, improving decision-making, and reducing costs.

One of the most developed AI technique in Saudi Arabia is NEOM Project. The NEOM Project is a planned city that will integrate smart city technologies located in the kingdom's northwest in Tabuk, Saudi Arabia. The robots are machines that can automatically perform a complex series of actions, particularly one programmable by a computer such as Sophia Robot, Sarah Chatbot Robot, Medical Robot, etc.

AI is considered the future state transformation engine for countries like Saudi Arabia. A future that cannot be delivered through hydrocarbon fuels. AI technology changed the way of thinking about energy resources. As Neom city which have been built in Saudi Arabia and designed to become the centre of a global technology hub.

As Saudi state, we may view Neom city as an experiment. It gives an early predictor of how AI is more involved in our lives. Thus, what is going to happen in the Saudi Arabia over the next ten years is likely to affect beyond economic, technological and the 'new future' of the AI growth.

<b>Abbreviations</b>
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AI	Artificial Intelligence
AUC	Area Under Curve
CNN	Convolutionary Neural Network
COVID-19	Coronavirus Disease of 2019
CPS	Cyber Physical System
CT	Computerized Tomography
CW	Constructed Wetland
EFL	English as a Foreign Language
E-Learning	Electronic Learning
FCM	Fuzzy Cognitive Maps
GDP	Gross Domestic Product
HR	Human Resource
HSFCW	Horizontal Sub Surface Flow Constructed Wetlands
IDC	International Data Corporation
IT	Information Technology
JIC	Jubail Industrial College
KKU	King Khalid University
KSA	Kingdom of Saudi Arabia
LMS	Learning Management System
MEA	Middle East and Africa
MIS	Muammar Information Systems
MIT	Management and Information Technology
M-Learning	Mobile Learning
NTP	National Transformation Program
SDAIA	Saudi Data and Artificial Intelligence Authority
UAE	United Arab Emirates
US	United States
UTAUT	Unified Theory of Acceptance and Use of Technology

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