

Harnessing AI Technologies to Develop Algerian Healthcare

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ARTICLE INFORMATION

Original Research Paper

Received: 10 /05 /2025

Accepted: 19 /08 /2025

Published: 21 /09 /2025

Keywords:

Keyword.1: Artificial

Intelligence

Keyword.2: AI Healthcare

Applications

Keyword.3: Health service

Keyword.4: The dangers of
artificial intelligence

Keyword.5: Healthcare

JEL Classification Codes: **I15, O33,
O38, L86, F63.**

Abstract :

This research paper aims to clarify the concept of Artificial Intelligence (AI) by addressing its definition, characteristics, benefits, and historical background. It also highlights the importance of utilizing AI technologies to develop and improve healthcare services, especially given the major advancements AI has brought across various fields. The study examines different types of AI and its applications, particularly in the healthcare sector. The findings reveal that Algeria is currently a consumer of technology rather than a producer and remains digitally dependent. Therefore, it is essential for Algeria to enhance its use of AI in the healthcare services market and compete globally by training medical personnel, investing in infrastructure, and conducting awareness campaigns to educate the public on this modern industrial revolution

Mots clés:

Mot clé.1: Intelligence artificielle

Mot clé.2: Applications de l'IA
dans la santé

Mot clé.3: Service de santé

Mot clé.4: Les dangers de
l'intelligence artificielle

Mot clé.5: Soins de santé

Codes de classification JEL **I15,
O33, O38, L86, F63.**

Abstract : Ce travail de recherche vise à clarifier le concept d'intelligence artificielle (IA) en abordant sa définition, ses caractéristiques, ses avantages ainsi que son contexte historique. Il met également en évidence l'importance de l'utilisation des technologies d'IA pour développer et améliorer les services de santé, notamment au regard des avancées majeures qu'elle a permises dans divers domaines. L'étude examine les différents types d'intelligence artificielle ainsi que ses applications, en particulier dans le secteur de la santé. Les résultats révèlent que l'Algérie est actuellement consommatrice de technologies plutôt que productrice et demeure numériquement dépendante. Il est donc essentiel pour l'Algérie de renforcer l'usage de l'IA dans le marché des services de santé et de rivaliser à l'échelle mondiale en formant le personnel médical, en investissant dans les infrastructures, et en menant des campagnes de sensibilisation pour informer le public sur cette révolution industrielle moderne.

1. Introduction :

Artificial Intelligence (AI) has become a transformative force across multiple sectors, including healthcare, where it plays an increasingly vital role in improving service quality, diagnostic accuracy, and patient care. In light of the global digital revolution, AI offers promising solutions to some of the most pressing challenges faced by healthcare systems, particularly in developing countries like Algeria. This paper seeks to examine the role of AI in healthcare, especially its application, benefits, and limitations within the Algerian context

Problem of the Study:

The recent rise in medical errors within healthcare systems has drawn international concern, especially due to the high rates reported by patients in public health institutions. These occurrences highlight the inevitability of human error in medical practice and the need for risk management. In response, AI has been introduced as a tool to assist medical professionals in diagnosis and high-precision surgeries, with the potential to reduce errors and enhance patient safety—thus offering a more reliable healthcare system.

Purpose and Importance of the Study:

This study aims to clarify the concept of AI and explore its practical use in the Algerian healthcare sector. It seeks to assess how AI technologies can be harnessed to improve healthcare service delivery. The importance of the study lies in its potential to guide decision-makers, healthcare professionals, and researchers in understanding the strategic role of AI in improving healthcare quality and accessibility. It also underscores the need for infrastructure development, medical staff training, and public awareness to facilitate AI integration in Algeria.

Literature Review :

Several previous studies have addressed the relationship between AI and healthcare:

1. **Salem Al-Aroud (2024)** – *The Risks of Artificial Intelligence on the Ethical System of Childhood*. This study explored how AI may negatively affect the moral and psychological development of children, emphasizing the role of guardians and educators in promoting awareness.
2. **Faihan bin Mutlaq bin Abdullah Al-Subaie (2024)** – *The Impact of Using Artificial Intelligence Technology on Providing Healthcare in the Kingdom of Saudi Arabia*. A field study focusing on the positive impact of AI on the efficiency and quality of healthcare services in Saudi Arabia.
3. **Ayah Shawqi Khater, Ayman Abdul Fattah Zaaqooq, et al. (2023)** – *Knowledge and Attitudes of Medical Students at Shams*

University Towards AI in Medical Education and Practice. The findings reveal that over 80% of students believe AI should be integrated into medical education and practice, reflecting a readiness among future doctors to embrace technological advancements.

Hypotheses : The study is based on the following hypotheses:

- Artificial Intelligence has transformed human cognitive intelligence into machine-based intelligence.
- AI contributes to delivering healthcare services more efficiently.
- Algeria is a technology exporter in the healthcare sector.

Study Approach and Methodology :

The research adopts a **descriptive methodology**, providing a theoretical overview of AI and its relevance to the healthcare field in Algeria. The study is based on secondary data, including academic articles, case studies, and official reports. It aims to present a comprehensive view of how AI is currently applied in healthcare and to identify the opportunities and challenges facing its wider adoption in Algeria.

2. Theoretical Approaches to Artificial Intelligence :

2.1. The Nature of Artificial Intelligence:

2.1.1 Definition of AI:

Today, AI has become an integral part of our daily lives. But what does it mean, and how can we benefit from its remarkable technologies?

The world is currently witnessing a competitive technological revolution led by AI—a branch of computer science that seeks to create machines capable of replicating human intelligence and performing tasks that require thinking, learning, and decision-making. AI involves learning, reasoning, self-correction, as well as planning and inference. It includes developing algorithms and mathematical models that can analyze data, draw conclusions, and offer solutions (annajah, 2025).

Origins and Development of AI

- **History of AI:**

The origins of AI date back to ancient times, when many philosophers imagined mechanical men that could be created somehow—a concept that gained traction in the 18th century and beyond. Philosophers began to consider the possibility of using non-human intelligent machines to replicate or manipulate human thinking, eventually leading to the invention of the digital computer.

About a century later, various proposals were made to test machines' abilities to mimic human actions, which led to the formal adoption of the term "Artificial Intelligence" in the 1950s. Since the mid-20th century, AI has undergone significant developments that have shaped public understanding of the technology.

- **Stages of the Development of Artificial Intelligence:**

The development of AI can be divided into several key stages as follows:

AI from 1900–1950:

This period marks the early emergence of the concept of AI. Many plays and science fiction films introduced the idea of robots—artificial beings capable of performing human-like actions in the real world. In Japan, the first robot was created in 1929 by Japanese biologist and professor Makoto Nishimura. This robot could move its head and hands and change its facial expressions (bakkah, 2025).

AI after 1950:

Following 1950, AI research by numerous computer scientists began to bear fruit. Alan Turing introduced the theory of "Computing Machinery and Intelligence," proposing the imitation game as a test of machine intelligence. In 1952, Arthur Samuel developed a computer program capable of independently playing checkers. In 1955, the first AI program, Logic Theorist, was created by Allen Newell, Herbert Simon, and programmer Cliff Shaw. In 1959, Arthur Samuel coined the term machine learning, proposing that computers could be programmed to play chess better than humans.

AI in the 1960s:

The 1960s saw significant growth in AI, including the creation of programming languages, robots, and studies presenting AI-powered characters. In 1961, a robot invented by George Devol in the 1950s performed tasks considered dangerous to humans. In 1964, Daniel Bobrow developed the STUDENT program to solve algebra word problems. In 1965, ELIZA—an interactive program that communicated in English—was developed by Joseph Weizenbaum. In 1966, the first general-purpose mobile robot, Shakey the Robot, was developed by Charles Rosen and 11 collaborators.

AI in the 1970s:

This decade witnessed reduced government support for AI research, despite rapid progress in robotics. In 1970, Waseda University in Japan introduced WABOT, a humanoid robot capable of vision, speech, and movement. In 1973, British government funding was reduced after mathematician James Lighthill reported minimal progress in the field. In 1979, Ph.D. student Hans Moravec created the Stanford Cart, a remote-controlled mobile robot that successfully navigated a chair-filled room without human intervention over five hours.

AI in the 1980s:

In 1980, Waseda University developed WABOT to interact with people, read musical scores, and play music. In 1986, Mercedes-Benz launched a driverless truck equipped with cameras and sensors, capable of reaching

speeds up to 55 mph. In 1988, programmer Rollo Carpenter developed the chatbot Jabberwacky to simulate fun, natural conversation (bakkah, 2025).

AI in the 1990s:

AI technology continued to grow with many innovations. In 1995, Richard Wallace created the chatbot A.L.I.C.E., incorporating natural language data sampling. In 1997, Sepp Hochreiter and Jürgen Schmidhuber developed Long Short-Term Memory (LSTM), a type of recurrent neural network (RNN) used in speech and handwriting recognition. That same year, IBM's Deep Blue defeated human chess champions. In 1998, Furby, the first robotic pet toy, was invented by Dave Hampton and Caleb Chung. In 1999, Sony introduced AIBO, a robotic dog capable of interacting with people and understanding over 100 voice commands.

AI from 2000–2010:

This decade witnessed rapid AI growth and the emergence of more intelligent entities. In 2000, Professor Cynthia Breazeal created Kismet, a robot with a human-like face capable of recognizing and mimicking emotions. Honda launched ASIMO, an intelligent humanoid robot. In 2004, NASA achieved a milestone by launching the autonomous Mars rovers Spirit and Opportunity. In 2007, Fei-Fei Li and colleagues developed ImageNet, a database of labeled images to assist in object recognition research.

AI from 2010–2018:

AI became part of daily life. In 2010, Microsoft launched the Xbox 360 Kinect, a gaming device that tracked body movements using a 3D camera and infrared detection. In 2011, Apple released Siri, a voice-controlled virtual assistant using natural language interfaces. In 2013, Carnegie Mellon researchers introduced Never-Ending Image Learner, a semantic machine learning system that analyzes image relationships. Between 2015–2017, AlphaGo defeated human champions in the board game Go. In 2016, the humanoid robot Sophia, capable of facial expressions and communication, was created. Google released Google Home, a smart speaker offering voice-based search and task management. In 2017, Facebook trained two chatbots to negotiate with one another. In 2018, Samsung released Bixby, a voice assistant capable of answering questions, giving recommendations, and seeing what the user sees (bakkah, 2025).

AI from 2020 to Present:

In 2020, Oxford University developed Curial, an AI system for rapid COVID-19 detection. In 2021, OpenAI launched DALL·E, a multimodal system that creates images from text prompts. In the same year, the University of California, San Diego created a four-legged robot powered by compressed air. In 2023, OpenAI released ChatGPT, a chatbot capable of holding conversations and answering human questions (bakkah, 2025).

2.1.3 Types of Artificial Intelligence :

Artificial Intelligence opens endless doors to innovation and development, all aiming to create a better environment and an easier life for individuals. It can be divided into several types, including:

- **1.3.1 Narrow Artificial Intelligence (ANI):**

This is the most common and widely used type today. It is characterized by its ability to perform a specific task or set of tasks efficiently but lacks the ability to think or learn beyond those tasks.

- **1.3.2 General Artificial Intelligence (AGI):**

This type is the goal scientists strive to achieve. It is designed to think, learn, and make decisions similar to humans across a wide range of domains.

- **Super Artificial Intelligence (ASI):**

This is the future form of AI expected to surpass human intelligence in all areas. It remains theoretical and speculative, but raises many questions about its potential impact on humanity (www.anasedu.com, 2025).

2.1.4 Characteristics and Advantages of Artificial Intelligence

- **Characteristics of Artificial Intelligence:**

- AI has many distinctive traits, such as:
- The ability to solve problems despite incomplete information ;
- The capacity to acquire and apply knowledge ;
- The ability to think and perceive ;
- The capability to learn and understand from past experiences ;
- Using previous experiences in new situations ;
- Handling complex and difficult cases with missing data ;
- Utilizing trial and error to explore different scenarios ;
- Quickly responding to challenging situations ;
- Distinguishing the relative importance of elements in a situation ;
- The ability to imagine, create, and visually interpret for decision-making (www.dspace.univ-adrar.edu.dz, 2025).

- **Advantages of Artificial Intelligence:**

Knowledge Representation:

AI programs use specific knowledge representation structures, unlike statistical programs. These include facts, relationships, and rules that form a knowledge base offering rich problem-solving data.

Optimistic Experimental Approach:

AI programs often tackle problems without known general solutions. Instead of sequential steps leading to the perfect solution, they try plausible approaches, adjusting strategies if the first choice doesn't yield quick results. For instance, solving a quadratic equation isn't considered AI, as the solution is known—but playing chess is, due to its uncertain next moves.

Handling Incomplete Information:

AI systems can sometimes provide solutions even when not all data is available at the required moment. However, these conclusions may still be correct.

Learning Ability:

AI can learn from past practices and experiences. It can also improve performance by considering past errors, generalizing information, identifying similar situations, and filtering out irrelevant data.

Reasoning Ability:

AI can deduce possible solutions for certain problems using known data and prior experience. Especially for complex problems where traditional methods are ineffective, AI uses inference strategies and logic laws, storing all possible solutions and applying reasoning algorithms (Bakr, 2017).

2.2 Applications of Artificial Intelligence

Since its inception, AI has sparked debates among scientists regarding its applications. Some see it as the ultimate path to a new societal era, while others fear it may lead to humanity's self-destruction. However, most scientists believe AI will play a crucial and positive role in the world.

AI applications in computer systems can emulate human cognitive processes such as learning, adapting, self-correction, and data-driven problem-solving. It also provides tools and techniques for building models that simulate human behavior (www.jipim.journals.eks.eg, 2025).

- **Artificial Intelligence Applications are Distributed Across Three Main Fields:**

Infrastructure Interface Applications:

These include:

Natural language processing

Speech recognition

Multisensory systems

Virtual reality

Smart Machine Applications:

These include:

Visual perception

Dexterity

Tactile sensing

Motor transport

Neural networks

Intelligent agents

Cognitive Science Applications:

These include:

Expert systems

Learning systems

Fuzzy logic

Genetic algorithms

These applications represent branches of AI used according to the intended purpose. Among the most important of these are:

- **First: Expert Systems**

Expert systems are specialized software programs designed to simulate the human reasoning of experts in a specific field of knowledge. They consist of two key components (www.jipim.journals.eks.eg, 2025):

First, the value of the software itself, which ensures the effectiveness of the expert system and is a key concern for developers.

Second, the expertise in the field, which must be mastered within the engineering discipline that seeks efficiency.

The expert system is designed as a model of the expert's knowledge and problem-solving ability. It is based on the concept of replicating the human expert's knowledge and storing it in a knowledge base within an information system that pertains to a specialized domain.

Key features of expert systems:

They are a type of computer software

They are a subfield of artificial intelligence

They are used as work assistants or at expert-level performance

- **Second: Neural Networks**

Neural networks are systems based on distributed knowledge rules across a bundle of programs and systems operating through many processors in parallel processing mode. They use logic and are designed to mimic the structure and function of the human brain. This is achieved through dynamic internal linking among processors that interact with patterns and relationships in the processed data.

Neural networks learn to distinguish data and are shaped and programmed throughout the training and learning phase. They also aid in decision-making. Therefore, designing them requires precise identification of internal data and converting that data into numerical values by following these steps:

Defining decision objectives based on priorities

Making the most effective decision from several possible options

Executing the decision and evaluating outcomes

- **Third: Genetic Algorithm Systems**

These are computer programs that simulate biological processes to analyze problems in evolutionary systems. Genetic algorithms in their current form were developed in 1975 by John Holland at the University of Michigan. They evolved during the early 1980s to become one of the key methods for tackling complex search problems and identifying models.

They are described as "genetic" due to their strong reliance on mimicking the functioning of genetic processes to reach optimal solutions. The technique is based on the idea of a computer program where possible

decision solutions compete against each other, and through evolutionary competition, the best solution survives.

These algorithms are applied in financial and banking sectors, logistics, and materials movement control.

Fourth: Fuzzy Logic

Fuzzy logic is one of the growing applications of artificial intelligence. While intelligent computer systems rely on precise and definite data, fuzzy logic systems deal with ambiguous, undefined, and probabilistic data through reasoning that mimics human reasoning. This allows for approximate and incomplete values and makes inferences based on them (www.jipim.journals.eks.eg, 2025).

This technology consists of a set of diverse concepts and techniques for expressing uncertain, variable, or real-world knowledge. It addresses topics that do not tolerate binary values or clear-cut truths. Unlike classical logic used by traditional computer programs—which operate on binary (true/false) logic—fuzzy logic explores phenomena by navigating the gray area between black and white.

This technique is used in banking applications such as:

Forecasting expected returns from securities

Risk management

Cash liquidity planning

Investment portfolio management

and other financial applications.

2.3 The Importance of Artificial Intelligence in Healthcare:

Artificial intelligence is considered the most transformative force in the modern world. Its impact on any field is seen as a revolutionary advancement—especially in healthcare, from hospital care units to clinical trials and drug development.

AI and its applications are revolutionizing the healthcare sector and all related services by reducing costs for both patients and healthcare institutions.

Investments from both the private and public sectors in healthcare-related AI are substantial. Statistics indicate that total investments were projected to reach around \$6.6 billion by 2021. More importantly, AI applications are expected to save approximately \$150 billion annually by 2026, mainly through enhanced operational efficiency and diagnostic accuracy.

2.3.1 The Importance of Artificial Intelligence in the Workplace:

All healthcare sectors and institutions, such as hospitals, are work environments that involve numerous administrative tasks. AI has made a clear impact in streamlining operations and increasing productivity.

Healthcare institutions are service-oriented by nature, and AI can engage with them effectively. It plays a fundamental role in enhancing the user experience—especially when the "user" is a patient.

One key aspect is monitoring and tracking, as AI deals with data from a supervisory perspective, constantly monitoring it and issuing reports when anomalies are detected.

This is achieved through automation technologies that rely on continuously available data—especially relevant to hospitals operating 24/7.

One such technology is Robotics Process Automation (RPA), which uses algorithms and machine learning (ML) techniques to handle repetitive administrative tasks like tracking and monitoring.

RPA also helps in accepting or rejecting applications—for example, job applications—by analyzing the applicant's data and comparing it to the criteria set by managers, after which it automatically decides whether to accept or reject the application (www.academy.com04, 2025).

2.3.2 Applications of Artificial Intelligence in Healthcare:

Patients can benefit from applications they may not even be aware of, all thanks to accurate diagnosis and a more effective approach to treatment. This is one of the first and most significant impacts of artificial intelligence. Among these applications are:

- **Robotic Surgery:**

These are surgical operations in which robots are used as intermediaries between the doctor and the patient undergoing surgery. These robots perform with high precision, allowing doctors to avoid large incisions in the body to access certain areas. With such technologies, surgeries can now be performed more efficiently.

Initially, these machines functioned as non-thinking tools under the control of physicians. However, they are now capable of making decisions. Instead of being mere instruments, all surgical robots worldwide could be connected via a unified software application that can make real-time decisions during surgery, such as determining the best incision point.

Moreover, these robots can provide a wealth of data through cloud computing and artificial intelligence by storing thousands of past cases and critical surgical decisions. All of this information can now be accessed via a smartphone by any doctor or medical student. This field is projected to reach an investment of \$40 billion by 2026.

- **Virtual Nursing Assistants:**

One of the most important aspects of the institution-consumer relationship is personalizing the service. This application offers a realistic nursing service powered by AI to enhance the patient's experience in hospitals and healthcare institutions.

It helps patients monitor their health status by analyzing symptoms, making accurate diagnoses, and arranging appointments with physicians. Instead of explaining symptoms verbally, AI-powered chatbots can identify symptoms precisely and provide a suitable diagnosis through the smart nursing system.

These technologies can also be extended beyond clinics and hospitals into the patient's home. For instance, if a doctor prescribes a specific diet or exercise regimen, the system can assist through smartphone reminders and scheduling. Additionally, it supports preventive measures tailored to specific diseases using machine learning (ML), algorithms, and previously mentioned RPA technologies.

- **Medication Error Prevention:**

One of the critical AI applications in healthcare is monitoring medication usage to reduce errors—sometimes even prevent disasters. Medication errors can be catastrophic, whether due to missed doses, switching medications, or prescribing the wrong drug. These mistakes can severely damage the immune system.

It's no surprise that this application is expected to receive investments nearing \$17 billion by 2026. AI assists patients by selecting the appropriate medication and ensuring it is taken correctly and on time.

It also helps prescribe the most accurate treatment, minimizing human error, especially when prescriptions are made as part of a routine without careful attention to the patient's diagnosis.

Smartphone applications can remind patients to take their medications on time, and personalized surveys allow AI to understand the patient's lifestyle and offer helpful tips for better health outcomes.

2.4 Artificial Intelligence and Cost Reduction:

Although AI technologies require significant investment and infrastructure, they are expected to save nearly \$230 billion annually in a country like the United States—a staggering figure. So, how does AI help save money?

2.4.1 Services and Operational Processes:

Operational and service sectors alone are estimated to account for \$113.7 billion in savings. Healthcare institutions serve thousands daily, and relying on outdated methods can result in the loss of billions.

2.4.2 Sales and Marketing:

AI also impacts sales and marketing, with potential savings reaching \$67.9 billion—particularly important for private hospitals and clinics in competitive environments.

2.4.3 Risk Management:

Healthcare institutions face daily risks—not only medical (such as infection transmission), but also administrative and decision-making risks. Through predictive analysis and data-based recommendations, AI simplifies these processes, saving over \$28 billion annually in this area alone.

2.4.4 Logistics Support:

From daily orders and shipments received by healthcare institutions, AI technologies can help save around \$23.5 billion annually through optimized logistics and inventory management (www.academy.com04, 2025).

2.5 Artificial Intelligence Variables (Opportunities and Challenges):

The use of artificial intelligence (AI) technologies in the healthcare sector poses numerous technical and operational challenges, such as identifying signs on vital organs, interpreting laboratory results, diagnostic imaging, heart rate monitoring, fluid balance assessment, and predicting specific medical outcomes like survival or mortality rates from surgeries or the duration of hospital stays (Nafla, 2024).

At the same time, AI offers many opportunities, especially since researchers are intensively working to minimize its drawbacks and maximize its potential. The topic of AI has gained substantial attention within the academic community, with more than 100 articles published annually over the past five years discussing how to improve medical services and reduce errors. This number exceeded 200 articles in 2022 and 2023 alone.

2.5.1 Opportunities of Artificial Intelligence:

The World Health Organization (WHO) issued its first global report on AI in health, along with six guiding principles for its design and use. The growing application of AI in health presents both opportunities and challenges for governments, service providers, and local communities.

According to WHO's latest guidelines, AI opens promising opportunities for improving healthcare delivery and medication access worldwide—but only if ethics and human rights are central to its design and use (WHO, 2021, 2025).

The report on ethics and AI governance in healthcare is the result of two years of consultations led by a team of international experts appointed by WHO.

WHO Director-General Dr. Tedros Adhanom Ghebreyesus stated: “Like all new technologies, AI has tremendous potential to improve the health of millions of people around the world, but it can also be misused and cause harm.” He added, “This important new report provides countries with guidance on how to maximize the benefits of AI while minimizing risks and avoiding its dangers.”

AI is currently used to improve the speed and accuracy of disease diagnosis and testing, especially in wealthier countries. It supports clinical care, enhances medical research and drug development, and aids in public health interventions such as disease surveillance and health system management.

Moreover, AI can empower patients to have more control over their health care and deepen their understanding of their needs. AI technologies offer key tools in emerging tech, contributing significantly to both performance and efficiency. Among the main opportunities:

2.5.2 Autonomous Control:

Most self-control systems—especially in healthcare—strive to improve performance by integrating AI technologies into their operations to execute

tasks flawlessly. These systems have garnered major attention in medical applications.

2.5.3 Speed of Execution:

AI systems provide ultra-fast responses measured in gigahertz, which speeds up service delivery. They can enhance the health system's capabilities, even during times of instability. Despite potential risks, speed gives an edge in long-term operations.

2.5.4 Information Superiority:

AI provides methods for handling massive data volumes required for big data analysis, a process that would otherwise require enormous effort and human resources (Sherif, 2024).

2.6 Challenges of Artificial Intelligence:

There are several critical challenges that must be addressed, including:

2.6.1 System Transparency:

AI-based applications must meet numerous essential requirements, such as high performance, safety, user trust, and transparency. Transparency is crucial, particularly as user trust often hinges on it. The needed level of transparency may vary depending on end-user expectations.

2.6.2 Big Data:

Developing AI applications in healthcare is complex, especially when it comes to collecting data from hospitals, which presents a logistical and technical challenge.

2.6.3 Data Shortage:

Many AI applications rely on vast amounts of high-quality data. Any shortage in quantity or quality can negatively impact the accuracy of outcomes.

2.6.4 Problem Simplicity:

Some issues may not require AI at all due to their simplicity and can be solved using traditional methods.

2.6.5 Lack of Qualified Personnel:

Implementing AI requires specialized human resources, and given the complexity of the technology, it can be difficult to find suitably trained professionals.

2.6.6 Ethical Challenges:

Dealing with ethical issues—such as fairness, rights protection, and accountability—is a major concern. Strict ethical policies must be established during AI development and use.

2.6.7 Cultural Patterns:

AI systems may face difficulties adapting to different cultural contexts, which can limit their effectiveness in achieving desired results across diverse societies (Al-Mutrafi, 2025).

For example, although private and public sector investments in developing and deploying artificial intelligence (AI) are critically important, the lack of

regulation in its use may prioritize the strong commercial interests of tech companies or the surveillance goals of governments over the rights and interests of patients and communities.

The report also emphasizes that systems primarily trained on data collected from individuals in high-income countries may not perform adequately for individuals in low- and middle-income country contexts (www.who.int, 2021, 2025).

3. Healthcare:

3.1 General Overview of Health Services:

3.1.1 The Concept of Health Services:

Health services are among the most important outputs of the healthcare sector, enabling its development and allowing for higher levels of human development. This is achieved through the coordinated efforts of a medical team in hospitals or clinics, such as when a doctor treats a patient. Healthcare can also become preventive care through the guidance doctors provide. It represents the level of performance expected by the patient in relation to the services they receive, highlighting the patient's role in shaping the quality of care provided.

3.1.2 Characteristics of Health Services:

Health services are considered among the most vital services due to their direct link to human health. They are characterized by several features, including:

Provided to all members of society;

Must meet quality standards, as they are related to human life;

Aim to deliver public benefits to individuals, institutions, and organizations alike;

Governed by national laws and regulations;

Continuous in nature and not subject to commodification;

Require the personal presence of the individual;

The quality standard is reflected through the patient's perception and understanding, which serves as the key indicator (Tayeb, 2020).

3.1.3 Scope of Health Services:

Most Arab countries have made notable progress toward universal healthcare coverage. In 2022, over 95% of the population in Jordan, the UAE, Bahrain, Saudi Arabia, Oman, Palestine, Qatar, Kuwait, and Libya had access to healthcare. The percentage ranged between approximately 71% and 94% in Tunisia, Algeria, Syria, Lebanon, Iraq, Egypt, and Morocco.

The healthcare access index varies significantly based on available data between rural and urban areas. Most Arab countries also face a shortage of medical personnel, with the number of doctors and nurses per 100,000

people ranging from 4 to 70 doctors and 6 to 165 nurses—below the global average of 170 doctors and 370 nurses per 100,000 people (Unified Arab Economic Report, Issue 44, 2024).

Additionally, many Arab countries suffer from a severe shortage of hospital beds. This is due to several factors, including weak investment in medical training and health infrastructure, as well as the migration of healthcare professionals due to uncompetitive salaries.

3.2. Potential Investment Areas in the Healthcare Sector:

There is a significant amount of capital being directed toward artificial intelligence in general, and especially toward the healthcare sector, according to Forbes magazine. Among the areas worth investing in within the health sector are the following:

3.2.1 Digitization:

Digitization, or the complete transformation of administrative operations into digital formats, involves the use of AI, network science, and many other technologies. Given that the Arab region is moving toward digitization at a reasonable pace, investing in the digital aspect of the healthcare sector presents a promising opportunity.

3.2.2 Interaction and Communication:

This refers to the relationship between patients or consumers and healthcare institutions, and how they interact with doctors, nurses, systems, and all services provided. This field is more patient-centered rather than administrative. Exploring this area could yield significant investment returns.

3.2.3 Diagnostics:

Investment here involves developing services and products that utilize AI and algorithms to provide accurate diagnoses and smart healthcare services (www.academy.com, 04, 2025).

3.3 The Role of Artificial Intelligence in Modernizing Healthcare Services Delivery:

AI plays a major role in supporting and improving the performance of healthcare services by using enabling technologies to enhance accuracy and efficiency. It also helps reduce human medical errors. Therefore, ensuring the future delivery of better healthcare services without such errors involves innovations in the following areas:

3.3.1 Disease Diagnosis:

AI can improve diagnostic processes by analyzing data more accurately and quickly. AI algorithms can collect and interpret medical data more effectively than humans, leading to better disease detection and personalized treatment plans.

3.3.2 Surgical Procedures:

AI plays an important role in enhancing surgical techniques by integrating robotic systems that assist in performing complex and delicate surgeries with greater precision using 3D technology.

3.3.3 Prescription of Treatment:

AI helps improve drug safety by analyzing data to predict potential side effects and avoid negative interactions with other medications.

3.3.4 Electronic Management of Medical Records:

AI can enhance the electronic management of medical files by transforming data into actionable insights, providing patients with faster information, and enabling more effective medical interventions.

3.3.5 Improving the Performance of Medical Teams:

AI helps improve the functional skills of healthcare teams and increases their awareness and efficiency.

3.3.6 Medical Decision-Making:

AI supports doctors by providing crucial guidance for accurate medical decisions based on patient data analysis, leading to improved treatment outcomes (Nafla Y., 2024).

3.4 The Six Principles for Ensuring Safe AI Use in the Health Sector:

To minimize risks and maximize the benefits of using AI for health purposes, the World Health Organization proposes the following principles (www.who.int, 2021, 2025):

3.4.1 Protecting Individual Autonomy:

Healthcare should ensure that individuals remain in control of health systems and medical decisions. Privacy and confidentiality must be protected, and patients should give clear and informed consent through appropriate legal frameworks for data protection.

3.4.2 Promoting Individual Well-Being, Safety, and the Public Interest:

AI technology designers must comply with regulatory requirements regarding safety, accuracy, and efficiency for clearly defined use cases. Quality control measures should be in place in real-world practices to ensure the responsible use of AI.

3.4.3 Ensuring Transparency, Comprehensibility, and Clarity:

Transparency requires sufficient information to be published or documented before the design or deployment of AI technologies. This information should be easily accessible and enable meaningful public consultation and discussion about how the technology was created.

3.4.4 Enhancing Responsibility and Accountability:

Although AI technologies perform specific tasks, relevant stakeholders are responsible for ensuring they are used appropriately by qualified individuals. Effective mechanisms must be available to raise questions and provide remedies to individuals or groups adversely affected by algorithm-based decisions.

3.4.5 Ensuring Equity and Inclusion for All:

Inclusion means designing AI for health in a way that promotes its use and benefits across the broadest population, regardless of age, gender, sex,

income, race, religion, sexual orientation, ability, or any other characteristic protected under human rights laws.

3.4.6 Promoting Responsive and Sustainable Artificial Intelligence:

Designers, developers, and users must continuously evaluate AI applications transparently during their actual use to ensure that AI meets expectations and requirements appropriately. AI systems should be designed to minimize environmental impact and enhance energy efficiency. Governments and companies should address the anticipated major changes in the workplace by training healthcare workers to adapt to AI systems and preparing for potential job losses due to automation.

These principles should guide future organizational efforts to ensure that the full potential of AI in health and public health is harnessed for the benefit of all.

3.5 Healthcare in Algeria:

3.5.1 Health Expenditure:

Between 2012 and 2017, Algeria allocated 8.1% of its gross domestic product to the health sector. This percentage is considered insufficient compared to developed countries and remains low relative to the effort needed to elevate Algeria's human development index through the healthcare sector.

3.5.2 Healthcare Coverage by Doctors and Nurses:

Healthcare coverage by medical staff showed fluctuating levels. In 2013, the coverage by doctors decreased by about 24%, due to an increase in population density without a proportional rise in the number of doctors. However, in 2015, the rate of increase in doctor employment reached 12.96%, despite the economic coverage crisis in Algeria.

As for nurses, their number ranged between 244 and 253 per 100,000 inhabitants between 2012 and 2015 (Tayeb, Healthcare in Algeria – Between Human Development Indicators and Reality, 2020).

There is an unequal distribution of doctors and nurses, especially in desert and inner regions, where some emergency departments in public hospitals face crowds of over 200 patients with at most two doctors. Medical care remains unbalanced and requires more attention and efficient management to properly cover this sector.

3.5.3 Problems Facing Healthcare:

Many diseases and epidemics hinder high-quality healthcare. From 2012 to 2016, there was a rise in several illnesses, such as meningitis, which increased by 46.19% in 2016 compared to 2012. This indicates that health services failed to contain the epidemic, especially in rural areas. Among the problems:

- **Lack of Specialized Hospitals:**

Algeria still suffers from a shortage of specialized public hospitals, particularly in remote and desert areas. For instance, cancer patients often

have to travel to major cities for treatment, increasing their suffering and health complications—or even travel abroad.

- **Lack of Medical Staff Training:**

Algerian medical staff tend to differ from those in neighboring countries in terms of training. They often lack proper qualification and responsibility, which stems from a shortage of experience and insufficient material and moral conditions that would improve performance.

3.6 Efforts to Develop Healthcare in Algeria:

A report by the National Economic, Social, and Environmental Council on social and human development showed a "notable" improvement in citizens' healthcare indicators between 2019 and 2023. This reflects the efforts made, especially in developing healthcare, implementing programs to manage priority diseases, and enhancing institutional frameworks.

The report also stated that the health situation of the population improved significantly due to various national health programs aimed at meeting the specific needs of each population group. This includes efforts to ensure equal access to healthcare, free and continuous public health services, and achieving health security.

The report noted that the life expectancy at birth reached 77.2 years in 2022, compared to 57.4 years in 1980, positioning Algeria among countries with high human development.

- **Child Mortality Rates:**

The infant mortality rate has decreased, reaching 17.7 per 1,000 live births in 2022 (equivalent to 16,872 children), compared to 21 per 1,000 live births in 2019 and 18.3 in 2021.

There is also a gradual decrease in the mortality rate for infants and children under five years old, which stood at 19.8 per 1,000 live births, down from 24.2 in 2019.

This improvement reflects the notable attention given to healthcare, as the total number of practitioners increased from 51,595 in 2019 to 58,945 in 2022 in the public sector, and from 43,990 to 49,477 during the same period in the private sector.

The number of "specialist" doctors rose to 21,501 in 2022 in the public sector, compared to 19,744 in 2019, while the private sector saw an increase from 14,927 to 18,218.

As a result, the coverage rate for specialist doctors improved from one specialist per 1,449 people in 2019 to one specialist per 1,150 people in 2022, and general practitioners increased from one per 1,175 people in 2019 to one per 1,181 people in 2022.

Regarding healthcare infrastructure, the report highlighted that health facilities were reinforced between 2019 and 2021 with new structures. The

number of public hospitals increased from 219 to 235, and specialized healthcare institutions grew from 79 to 91 during this period.

In parallel, the public authorities launched several programs aimed at children and infants, including the expanded vaccination program (PEV), programs for combating diarrheal diseases in children, managing acute respiratory infections (IRA), and maternal and child nutrition programs. A multi-sectoral national strategic plan was also launched to combat risk factors for non-communicable diseases (2022-2030), based on four main areas: promoting healthy nutrition, exercising, enhancing physical activity, combating smoking, and strengthening intersectoral coordination. This was accompanied by the establishment of the national multi-sectoral committee for the prevention and control of communicable diseases, as well as the national cancer prevention and control committee.

In the first half of 2023, the number of chronic disease patients benefiting from social security coverage reached 5.1 million, up from 4.7 million in 2021, indicating an improvement in social coverage for this group.

As for drug abuse prevention, a law concerning the prevention of drugs and psychotropic substances and the repression of illegal use and trafficking was issued in 2023, along with a national prevention strategy. The institutional framework for the health sector was also reinforced with the creation of the National Health Security Agency, the National Health Observatory, and mobile teams in some public institutions (www.aps.dz/ar/sante/science-technologie, 2025).

• **Health Development Prospects in Algeria by 2025:**

The increasing population density in Algeria has significantly impacted health demand, as life expectancy at birth is expected to rise to 80 years, leading to an 11.9% increase in the aging population by 2025. Additionally, child mortality is projected to decrease by 5%, and maternal mortality by 8.8%. These trends will increase the demand for healthcare services for the elderly, especially due to chronic diseases (Dahal, 2019).

The development of the health sector aims to implement programs to strengthen the health map in public hospitals, improve access to healthcare, and continue maternal and child health services to reduce mortality rates. It also includes developing various surgical emergency services and specializing in rare diseases using AI technologies, as well as treating drug addiction and mental health conditions with modern techniques, including neurosurgery, vascular surgery, and organ transplantation.

This work can only succeed with the efforts of the health authorities, who must adapt the basic medical training curriculum by integrating AI tools aimed at improving users' capabilities and keeping them updated with advances in medical and biotechnological discoveries.

6-1 Using the smart application "Doctors of Algeria" as a model

Image No. (01): Interface of the "Doctors of Algeria" application



Source: Image taken from the app: "Doctors of Algeria"

This application is available for download on the Play Store and includes a directory of doctors' phone numbers and addresses, clinics, Algerian doctors, clinics in all states, hospitals, pharmacies, medical analysis laboratories and even the phone numbers of blood donors, civil protection and others.

- This application offers a free service that facilitates communication between doctor and patient.
- The information can be continuously added and corrected, bringing together the actors involved in the healthcare process in Algeria.

The application shows various shapes that were organized and linked according to the vision of patient comfort, while the colors were related to the medical profession and the doctor's dress, represented in white and blue in different shades on most pages of the application in addition to green and red, the use of these colors was prominent for the user, for example the blue color indicates safety, confidence, stability and success, love of the profession in addition to reliability and calmness.

The white color means extension, clarity and saturation in providing endless services and seriousness in work. The green color, which is present in a small percentage and in all pages of the application, gave an image of calm with prominent colors, so these three colors dominated the application in addition to some colors such as gray, red, yellow, black and pink gave an aesthetic touch to support the application, and many pictures were used that

carry everything related to the medical profession and the body of the patient members, which made the content of the application distinct.

The application is available in both Arabic and French, as Arabic is the official language in Algeria, and French is the common language for doctors and others. For reference, all the information in the application is written in Arabic and directly below it is a translation in French, but it is a bit of an obstacle for those who are proficient in English.

6.1.1 Method of communication between patients, doctors and others in the health care process through the application "Doctors of Algeria"

The application contains several means of communication, including the availability of the dimension of continuity through phone numbers and e-mail, links related to updating health information through available websites, the availability of icons for clarification and comment, and the possibility of deletion, all these features make it one of the most important outputs of artificial intelligence in developing health services and ensuring continuous communication between different actors (samia, 2024).

6.1.2 Types of health care services in the "Doctors of Algeria" application

The application provides several databases, including:

- A database of doctors of all specialties in all provinces;
- A database of blood donation centers in all provinces.
- A database of blood donation centers in all provinces.
- A database of pharmacy addresses.
- A database that includes the sale of medical and parapharmaceutical supplies.
- Addresses of medical analysis laboratories.
- Home for the sick.
- Requesting ambulances;
- Requesting a medical job.
- Civil protection;.
- Eyeglasses manufacturers.

This application contributes significantly to the development of health care for patients in Algeria, and makes it easier for them to benefit from remote services to minimize effort, time and convenience.

Table (01): Future uses of artificial intelligence in the healthcare sector in Arab countries

Field of use	How to use	The direct benefits
Integrating artificial intelligence technologies in medical education	Establish educational curricula that include the fundamentals of artificial intelligence in	Training workers to improve diagnostic efficiency

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	the field of imaging, specifically.	
Medical Imaging	Using deep learning algorithms and convolutional and generative adversarial neural networks	The efficiency of analyzing and enhancing medical images for rapid detection of anomalies.
Medical tourism	The use of artificial intelligence in precise diagnosis, cancer treatments, and hair transplantation	Encouraging tourism in Turkey and benefiting from health services.
Attempt to eliminate medical errors	The use of artificial intelligence in identifying medical errors and improving the quality of services.	Improving the quality of healthcare and reducing medical errors.
Evaluation of technology in the healthcare sector	Integrating artificial intelligence technologies and programs in training	Improving the quality of health technology assessment and achieving effective outcomes.
Development of artificial intelligence in the healthcare sector	The use of artificial intelligence in disease diagnosis	Improving the quality of healthcare and achieving effective results

Source: :elham ali sidahmed abdallah-mohamed ali alshahrani,**new application of intelligence in the medical field and usage challenges in arab countries** (alshahrani, 2025)

Conclusion:

Health is not only a fundamental right but also a key resource for social, economic and personal development, Algeria has made several efforts to protect and promote the health of the population, health policy is a choice between many alternatives, and it is the result of negotiations between various stakeholders expected to be representative of society for decision-making such as social solidarity, social justice and access to health care, the Algerian health system may face many criticisms from citizens or unions, but this does not deny that it receives local and foreign praise in some aspects, which puts it in the choice of readiness to use artificial intelligence.

ICT expert Dr. Younes Karar believes that Algeria is ready to use artificial intelligence in the health sector because this technology has no limits in a specific field, and its use in the medical field has become normal.

Algeria is a consumer of this technology, not a producer and not an exporter of it, relying on foreign technology, so to reach the use of artificial intelligence, it goes through three stages, it has no choice but to benefit from imported technology, so it must develop technology with international companies such as China and the United States of America, universities and research centers, by signing agreements between medical colleges and computer information institutes through artificial intelligence applications and their development, and creating special Algerian applications to embody digital sovereignty, such as the application “Doctors of Algeria” and other new applications issued as ‘Shafini’ application and “Hana” application, the success of the smart.

Results and Recommendations:

Strengthening regulations and establishing a clear legal framework for the use of AI in healthcare services marketing.

Providing specialized training programs to enhance workers' knowledge of AI applications.

Investing in infrastructure and developing technical systems to integrate AI.

Organizing awareness campaigns to increase the acceptance and learning of AI in healthcare.

Increasing attention to knowledge modeling and human expertise in the healthcare sector to avoid system challenges.

Collaborating with various entities to use artificial neural network systems to leverage big data management challenges.

Ensuring the patient is the primary focus of attention from officials to meet health needs promptly.

Training medical staff on how to use the latest AI technologies.

Supporting doctors with AI to make better, more accurate, and timely diagnoses.

Creating an electronic information system that allows efficient and secure sharing of patient files between medical teams.

Enhancing the tracking of drug effects and providing guidance on adjusting doses or changing treatments based on therapeutic data analysis results.

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