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Digital Transformation in Healthcare Management

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ABSTRACT

This paper delves into AI's transformations in the healthcare industry. It explores AI's penetration in healthcare, its transformative effects, and key management challenges, particularly in administration, human resources, and ethics. The research findings include a personal perspective based on extensive documentation and the introduction of a significant proposal. This HDMS model conceptualizes a digital management system for the healthcare industry.

Keywords: Digital Transformation; Healthcare; Management; Human Resources; Ethics; Model

Abbreviations: AI: Artificial Intelligence; NLP: Natural Language Processing; ANN: Artificial Neural Networks; NCEHC: National Center for Ethics in Health Care; HDSM: Healthcare Digital System Management

Introduction

Artificial Intelligence (AI) has become an integral part of our lives, from personal devices to household appliances, and it is making its mark across the globe. While AI may be less developed in some regions, advanced economies like the USA, Canada, Germany, Holland, Japan, China, India, and others are witnessing a rapid acceleration in the development of intelligent machines. This global trend, driven by the power of globalization, is not just a challenge but also a beacon of hope, compelling industries worldwide to compete or adapt to the new technological landscape. The advancements in AI technology, such as automation (deep learning, machine learning, machine vision), generative AI (Natural Language Processing (NLP) and Artificial Neural Networks (ANN)) and robotics, and also the implementation of procedures, such as algorithms, augmented intelligence, and augmented reality, are evident in a wide range of sectors. These include manufacturing, energy, sales and marketing, financial services, biotechnology, media and entertainment, facilities and services, community and lifestyle, agriculture and farming, healthcare, education, landing and investments, and many others (Doval, et al. [1]). These technologies reshape the healthcare sector, leading to substantial healthcare delivery and management changes. AI in the healthcare industry is a double-edged sword. While it offers numerous benefits, including reduced physical effort and working time and improved product and service quality, it also presents a host of challenges, particularly in business management and public services.

These challenges, coupled with concerns about the future of the workforce and adherence to professional ethics, create a complex landscape that we must navigate with a careful and strategic approach to digital transformation in healthcare management. All these aspects, briefly presented, lead to deep transformations in the healthcare industry and, of course, in system management. System transformation in this digital age represents a profound change that requires an inventive strategy and a system model. In this context, the proposed HDMS model, which conceptualizes the digital management system in the healthcare industry, holds the potential to guide and facilitate these transformations (Damborg, [2]). highlights four aspects that management must consider when changing the traditional system into a digital one: ignorance (lack of digital knowledge), fear (of leaving tradition), the unknown (it is considered an adventure), and diffusion (the risk of digital effort). Of course, these forces against

change can be deactivated if we consider the reality that digitization has become necessary. Although in many countries, the medical system is coordinated at the government ministry level and by territorial agencies, there are many private companies, some even listed on the Stock Exchange, that produce medical equipment and devices, medicines, and other necessary products, and others that offer medical services or laboratories. Most are in the USA and advanced countries in Europe, Japan, China, and others.

For example, The Top 100 Healthcare Technology Companies of 2023 (a report of The Healthcare Technology, available on the Internet) [3] or the Top 43 companies using AI in 2024 in the USA (Gottsegan, et al. [4]). All these are businesses that work to obtain profit, and people with medical problems (patients) are conditioned by the decision of the medical service provider regarding the conditions of using the health insurance or their full payment.

Scope and Methodology

In the context presented succinctly above, this work aims to foray into the healthcare industry to observe the level of AI implementation and propose a model for changing the management system. The research is fundamental, based on secondary information from the indicated references and from one's observations and knowledge. The methods used are analysis, synthesis, and conceptualization.

Literature Review

A series of published works were documented to realize the proposed model.

AI in Healthcare

The global healthcare market was valued at USD 20.9 billion in 2024 and is estimated to reach USD 148.4 billion in 2029. Growth is driven by the generation of big data, the need to reduce costs, computer science advances, and increased partnerships (Global Forecast to 2029 report, [5]). Payers, care providers, and life sciences companies already employ several types of AI. The key categories of applications involve diagnosis and treatment recommendations, patient engagement and adherence, and administrative activities (Davenport, et al. [6]), using AI technology (Machine Learning, Natural Language Processing) and Applications (Medical Imaging and diagnostics, Patient Data and Risk Analysis) (Global Forecast to 2029 report, [5]). The main uses of AI in healthcare are presented in Table 1. Recent advancements in healthcare delivery have given many patients access to advanced personalized healthcare, improving their well-being. The success of IoT in various application domains indicates its acceptance and integration with wearable sensors and AI technologies for quality healthcare delivery. Smart technologies and sophisticated instruments (such as smart wireless and wearable sensors) have substantially risen for rapid monitoring and control of patients' situations via prompt access and continuous assessment of patients' vital health signs (Junaid, et al. [7]).

Table 1: The main uses of AI in healthcare.

No	AI technology/ algorithms	Healthcare applications	Source
1	Machine learning	precision medicine – predicting treatment protocols	(Lee, et al. [25])
2	Neural network	determining whether a patient will acquire a particular disease	(Sordo, [27])
3	Deep learning	recognition of potentially cancerous lesions in radiology images	(Fakoor, et al. [23])
4	Radiomics	detection of clinically relevant features in imaging data	(Vial, et al. [28])
5	Natural language processing-NLP	It can analyse unstructured clinical notes on patients, prepare reports (e.g., on radiology examinations), transcribe patient interactions, and conduct conversational AI	(Davenport, et al. [6])
6	Expert systems based on collections of 'if-then' rules	employed for 'clinical decision support'	(Vial, et al. [28])
7	Surgical robots	improving surgeons' ability to see, create precise and minimally invasive incisions, stitch wounds, and so forth; it includes gynaecologic surgery, prostate surgery, and head and neck surgery	(Davenport, et al. [22]); (Utermohlen, 2018)
8	Smart devices, specifically wearable sensors	seeking to derive therapeutically important health-related data from physical (body) indicators such as heart rate (HR), blood pressure (BP), body temperature, respiration rate, and body motion]	(Majumder, et al. [26])
9	Robotic process automation-RPA	used for repetitive tasks like prior authorization, updating patient records, or billing; administrative work (including claims processing, clinical documentation, revenue cycle management, and medical records management).	(Hussain, et al. [20, 21, 24])

Management in AI Healthcare

In healthcare management, a series of activities may or may not lead to realizing an effective and efficient medical act. The most common are resource allocation, data management, administrative activities, decision-making, provision of specialized workforce, and compliance with ethical principles in the profession. However, using AI leads to a series of benefits and challenges.

Data Management

Because important data could be lost or it is difficult to connect data for developing new drugs, preventative medicine, and proper diagnosis, AI can work with big data and connect information in minutes. This can reduce the time and costs of healthcare administrative processes, contributing to more efficient daily operations and patient experiences (Daley, et al. [8]). As a structured, evidence-based assessment of the clinical, economic, social, and ethical impacts of existing technologies, Health Technology Reassessment -HTR may be a means of achieving optimal use, managed exit, and better value for money from technologies used in healthcare (Soril, et al. [9]). According to the National Center for Ethics in Health Care (NCEHC), employees can be influenced to "do the right thing" when managers prioritize ethics, communicate clear expectations, and practice ethical decision-making. With the digitalization of healthcare systems, healthcare leaders must protect the data within their care (Alexander, et al. [10]). Due to attacks and service disruption in the hospitals and clinical environment, there is a high demand for delivering security awareness and training programs (e.g., training to detect phishing emails) for healthcare professionals, with participants being nurses, doctors, admin personnel, and management teams (Nifakos, et al. [11]). Many hackers and types of digital threats affect data security; therefore, 'A manager must use the following actions in his preventive and risk avoidance strategy of cyber threats: think, invest, train, save, update, communicate, monitor, ensure, collaborate, and apply diplomacy in relationships' (Negulescu, et al. [12]).

Human Resources

Artificial Intelligence (AI) has the potential to ease the human resources crisis in healthcare by facilitating diagnostics, decision-making, big data analytics, and administration, among other things. However, we must first tackle the technological, ethical, and legal obstacles to this (Mesko, et al. [13]). The healthcare workforce crisis is due to at least three major issues: doctor shortages worldwide, the aging and burnout of physicians, and a higher demand for chronic care. An effective system depends on the availability, accessibility, acceptability, and quality of its health workers (WHO, [14]). However, AI does not cover the whole process of treatment: empathy, proper communication, and the human touch are still equally essential. No application, software, or device can replace personal connection and trust. The role of the human physician is inevitable, but AI could be a very useful cognitive assistant (Mesk, et al. [13]).

Ethics

As (Varkey, [15]) mentions, there are four principles of ethics in healthcare respectively: beneficence and nonmaleficence (traced back to Hippocrates's "to help and do no harm") and autonomy and justice (evolved later). Although these principles are known and applied by medical personnel with few exceptions, AI algorithms can distort objectivity if there is not enough data from genetic studies and discoveries or in a situation where AI algorithms take over the authority and decision, and thus ethical violations can occur, such as would be 'subtle discrimination, correct diagnosis in a particular case, loss of confidentiality, loss of personal responsibility in the relationship between physicians and patients (Char, et al. [16-28]).

Observations, Results, and Discussion

Following the investigations carried out, the following general aspects are found:

AI in Healthcare

AI is used in healthcare in six dimensions:

1. Medical services for patients (e.g., remote care, telehealth platform for recommendations and prescriptions, virtual assistant, applications for appointments, robot for waste recovery at home, digital market).

2. Medical services for medical personnel (e.g., cloud-based platforms for transmitting information, secure video, voice, or text communications; physician scheduling software; centralized call and message tracking; video games that mimic real medical procedures; technology AI for the detection of chronic diseases - cancer, diabetic retinopathy, diabetic macular edema).

3. Pharma production (biotechnology enabled by AI agents; big databases; optimized drug development protocol; consumer DNA kits and personal genetic and fertility tests).

4. Research for new scientific discoveries (e.g., launching digital health products and integrating solutions to accelerate research and development processes for new therapies).

5. Production of medical equipment and devices: (e.g., specific equipment, maintenance; medical devices assisted by AI technology; surgical robots; clinical terminology management).

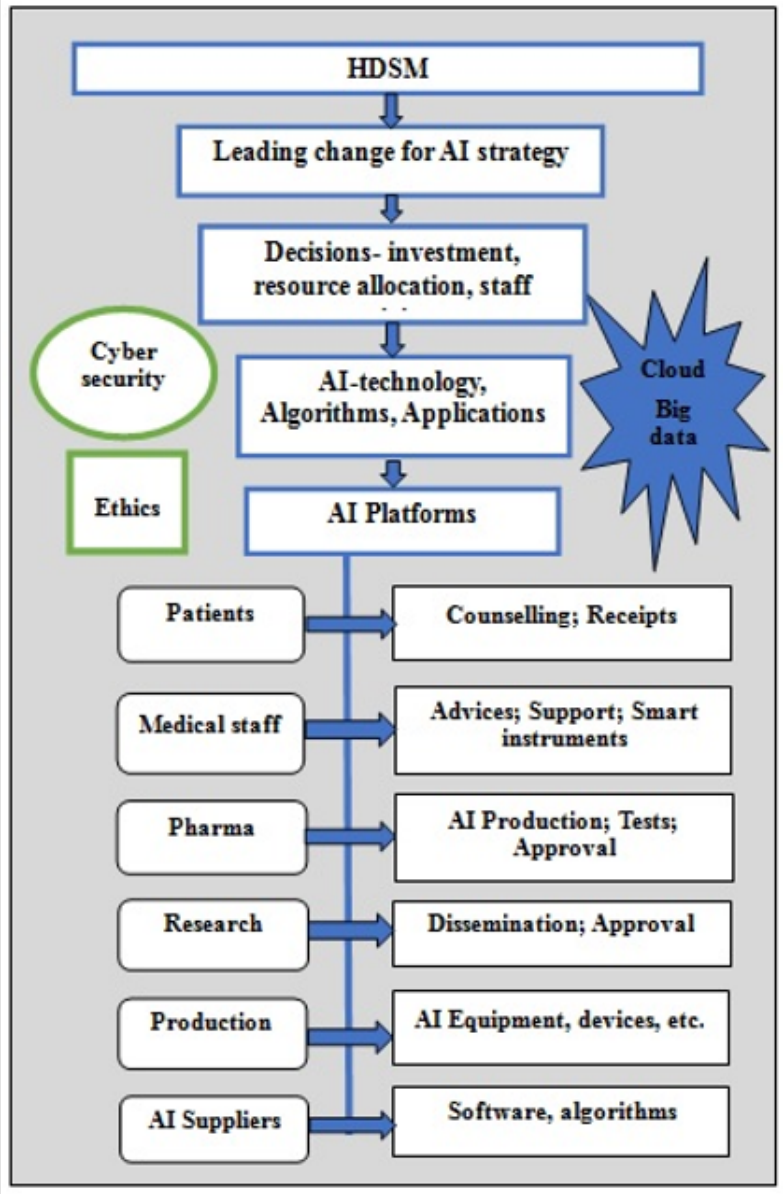
6. AI technology production and services (e.g., software, algorithms, applications, chatbot, cyber security, etc.). Through the increasingly advanced use of AI in healthcare, patients are expected to have easier access to medical services and medical personnel to serve more patients, but this also implies lower costs.

AI in Management

Besides the efficiency of the Medical Act, the main points of particular interest in managing the health system are administration,

workforce, and ethics. In administrations, whether we are referring to the ministry, territorial agencies, hospitals, clinics, or medical offices, AI represents undisputed support in the rapid use of data, in patient appointments or the supply of materials and medicines, in checking the history of diseases and personalized treatments on patients, and in correlating and anticipating various aspects in decision-making.

In terms of human resources, AI brings benefits in general, as it partially replaces the lack of specialists or increases productivity measured in the number of patients served per doctor. Also, AI tools simplify and accelerate personnel recruitment, training, and evaluation. On the other hand, there is the possibility that in the future, some employees will lose their jobs, especially in those activities where intelligent machines can replace them. The relevant negative aspects are related to the difficulty of controlling compliance with ethical principles, especially the personal confidentiality of patients and medical staff and the veracity of the medical act. The unethical aspects of intelligent machines are, on the one hand, the responsibility of the people who work in the system, such as the correctness of data entry, coding, and data correlation algorithms, and, on the other hand, cybercrime intervenes, through which they steal, destroy, or sell data.



Note: Source: authors' concept

Figure 1: Healthcare Digital System Management (HDSM) Model.

Healthcare Digital System Management (HDSM)

The need to implement some management models for the sanitary system is noted. For this purpose, the self-designed model called Healthcare Digital System Management (HDSM) could be used (Figure 1). The organization's management has led the change towards using AI and fighting against the forces that oppose the change. The strategy must be coherent, well-documented, and flexible. The main concern must be to invest in everything new in the field of AI application in health, allocate financial and human resources, and apply workforce training programs. Employees use equipment powered by AI technology and specific algorithms for different activities and questioning platforms. In establishing the database, the operators are instructed to work very carefully to ensure the quality of the information entered and use only verified and certified algorithms to ensure the viability of the correlations and ethical principles. The data is stored in the cloud to ensure access speed and cyber security. Access to the platforms is ensured depending on the relationships between the six actors involved in the system: patients, medical personnel, drug manufacturers, equipment manufacturers, research, and AI manufacturers, in compliance with the principles of ethics and data security. Any organization in the health field can use the exposed model with the necessary adaptations.

Conclusion

The work highlights some aspects that reveal the use of AI in the health industry, both in communication and patient services and in the support provided by intelligent technology to doctors and staff in hospitals, clinics, and medical offices. However, the advance of technology is evident in research, the production of medicines, the production of equipment assisted by artificial intelligence, and, of course, in software production. The use of AI in health brings benefits, both for the medical staff and for the patients. These benefits materialize in the speed of offering services, increasing their quality and productivity, and reducing indirect costs. However, in the current phase, several risks exist regarding cybersecurity and compliance with ethical principles. Effective management, the use of accredited software, and investments in cyber security can diminish these shortcomings. The proposed HDSM model represents a challenge for all health organizations not yet convinced that digitization represents the future.

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