

Doctor Resistance of Artificial Intelligence in Healthcare

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ABSTRACT

Artificial intelligence (AI) has revolutionized healthcare by enhancing the quality of patient care. Despite its advantages, doctors are still reluctant to use AI in healthcare. Thus, the authors' main objective is to obtain an in-depth understanding of the barriers to doctors' adoption of AI in healthcare. The authors conducted semi-structured interviews with 11 doctors. Thematic analysis was chosen to identify patterns using QSR NVivo (version 12). The results showed that the barriers to AI adoption are lack of financial resources, need for special training, performance risk, perceived cost, technology dependency, need for human interaction, and fear of AI replacing human work.

KEYWORDS

Artificial Intelligence, Barriers to Innovation Adoption, Digital Health, Digitalization of healthcare, Doctor's Resistance, Innovation Resistance Theories, Medical technologies, Qualitative Research

1. INTRODUCTION

The technological innovation, more precisely the digital revolution in medicine (usually noted as medical technology), is profoundly transforming the way healthcare is managed and handled (Lenz & Reichert, 2007) by abolishing old assumptions and creating new perspectives for innovation and improvement of medical processes (Lenz et al., 2012). "Medical Technology" is a wide range of tools that make it possible for health professionals such as Doctors to provide patients and society with an improved life expectancy and quality by reducing complications, performing early diagnosis, ameliorating treatment, and finally reducing the length of hospitalization (Briganti & Le Moine, 2020).

Medical technologies were mainly defined as classic medical devices such as prosthetics and implants. However, the rise of smartphones, sensors, wearables, and communication systems has radically transformed medicine by introducing Artificial Intelligence (AI) powered tools (such as applications) in very small sizes (Steinhubl et al., 2015). As a component of 4.0 industrial revolution, AI has gained a massive progress and revolutionized medical technologies (Ye et al., 2019). Within health care, AI is becoming a major constituent of many applications that is used to accomplish a wide range of roles mainly clinical decision support and remote patient monitoring, drug discovery, patient administration, risk prediction and management, health care intervention, medical error reduction, productivity improvement, virtual assistants, and hospital management. Medical fields have already started to gain from the multiple benefits of AI applications and methods such as radiology, pathology, dermatology, and ophthalmology (Esteva et al., 2017; Hosny et al., 2018; Rusk, 2015).

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Artificial intelligence is commonly defined as a component of computer science that is able to resolve complicated problems with multiple programs and an immense volume of data but little theory (Peng et al., 2010). It is commonly divided into two types: physical and virtual. Virtual AI involves deep learning applications (e.g., image processing) in order to help doctors with management and diagnosis of disease states. However, physical AI involves mechanical advances i.e. physical objects and medical devices, such as robotics in surgery (Ellahham et al., 2020; Hamet & Tremblay, 2017). Research into the advantages and importance of AI technology in healthcare is increasing (Fast & Horvitz, 2017) however workforce willingness and preparation is not well understood (Goldsack & Zanetti, 2020). Regardless its benefits, A number of doctors still resist the implementation of AI technologies in healthcare (Abdullah & Fakieh, 2020; Fan et al., 2018; Oh et al., 2018). There is a clear lack of research on doctor's resistance of AI in healthcare and there is no similar study has yet been conducted in Tunisia.

Hence, our main objective is to obtain an in-depth understanding of the barriers to doctors' adoption of Artificial Intelligence in healthcare. We should note that most AI health technologies are implemented in and developed by developed countries, their implementation in developing countries such as Tunisia is still recent (Alami et al., 2020; Wahl et al., 2018).

2. ARTIFICIAL INTELLIGENCE IN HEALTHCARE AND RELATED STUDIES

The founding father of Artificial Intelligence (AI), Alan Turing (1950), defined AI as 'the science and engineering of making intelligent machines, especially intelligent computer programs. Marvin Minsky (2020) simply define AI as a technology that can do a task which is perceived as a smart one by human. In other Words, AI refers to the science and engineering of producing intelligent machines, through a set of rules (algorithm), which the machine follows to imitate human cognitive functions, such as learning and problem solving. AI systems have the ability to anticipate problems or deal with issues as they come up in adaptive and intelligent manner. AI's strength is in its potential to learn, analyze and recognize patterns and relationships from huge multidimensional and multimodal datasets (Bajwa and al., 2021).

Artificial Intelligence (AI) is progressively automating decision-making in different industry sectors such as healthcare, education, criminal justice systems, organizational management, and public assistance (Lee and Rich, 2021).

2.1 The Beneficial Role of Artificial Intelligence in the Healthcare

Artificial intelligence (AI) is increasingly changing the healthcare system. Artificial Intelligence (AI), Robotics and Big Data created unprecedented opportunities and potentials in healthcare (Lee and Rich, 2021). In health care, AI can be divided into two categories. The first category is the attempt to resemble human cognitive functions such as sensing and recognition by computers. And the second category is the creation of tools to accomplish tasks which human action is necessary (Jha & Topol, 2018). Moreover, Artificial intelligence is not composed of a simple one technology, but instead a collection of them. One of this technology is Machine learning (ML). ML is a statistical technique that learns by providing models with data. It is the most known form of AI (Davenport & Kalakota, 2019). In healthcare, ML is used in predicting what treatment protocols that should be used on a person depending on its attributes and the treatment context (Lee et al., 2018). And the most complex forms of machine learning contain deep learning which anticipates results. It is used in healthcare to recognize potential cancerous lesions in radiology images (Fakoor et al., 2013).

AI technology play a vital role on diagnosis, treatment protocol development, patient monitoring and care, personalized medicine, robotic surgery, and health system management (Vijai,& Wisetsr, 2021).

1. **Machine Learning and Radiology:** Several researchers from Osaka University have evolved a deep-learning algorithm that can effectively diagnose several neurological diseases including epilepsy. As this disease usually spreads across the brain, it's important to identify abnormal scans as early as possible in order to improve patients' treatment options and ultimate outcomes (Vijai & Wisetsr, 2021).
2. **Robotics:** Its applications in the healthcare sector include robot-assistants in surgeries, micro-robots fixing damage from the inside and robotic arms for amputees which are already in use. Also, researchers are predicting telepresence robots that examine patients in order to create a free time for medical professionals. AI is getting progressively sophisticated at doing what humans do with more efficiency and at a lower cost (Vijai & Wisetsr, 2021).
3. **Drug Discovery:** AI solutions are being created to identify new possible therapies from large databases of information on existing medicines which could be reformed to target critical diseases such as the Ebola virus. This could not only enhance the efficiency and success rate of drug development but also accelerate the process to bring new drugs to market in response to deadly disease threats (Vijai & Wisetsr, 2021).

2.2 Related Studies

Different previous studies were conducted about AI in healthcare (Table 1).

Maskara et al. (2017) examined Doctor's acceptance of AI in the medical field. The sample is composed of ophthalmologists, dentists, cardiologists, and surgeons. Face-to-face and Phone-based interviews method was used to understand doctor's awareness and perception of AI in healthcare. The participants were conscious of AI application in their field and its usefulness.

Oh et al. (2019) investigated doctors' attitudes toward medical AI applications. they conducted a quantitative study by an online questionnaire distributed to 669 participants. The results revealed that doctors' attitude toward AI employment in medicine was positive.

Sarwar et al. (2019) explored pathologist's perspectives toward AI implementation in clinical practice from 54 countries. A questionnaire was distributed to 487 pathologists. Their findings showed that pathologist have a positive attitude toward AI. 75% of the respondents expressed that AI plays an important role in diagnostic as it enhances the efficiency and quality of patient care in pathology.

3. INNOVATION RESISTANCE THEORIES

When implementing a particular innovative product or service, users express two different reactions: innovation acceptance or resistance. Despite the potential of AI in enhancing the quality of care and patient safety, it encounters difficulty or fail in implementation. These failures can be explained by doctor's resistance (Bartos et al., 2011).

Kim and Kankanhalli (2009) described user resistance as the refusal of a consumer to the transformation applied in a particular innovation. In other words, it is a response to a current situation

Table 1. Previous studies on AI in healthcare

Authors	Focus of the study	Nature of the study
Maskara and al. (2017)	Doctor's acceptance of AI in the medical field	Qualitative Research
Oh, and al. (2019)	Doctors' attitudes toward medical AI applications	Qualitative Research
Sarwar and al (2019)	Pathologist's perspectives toward AI implementation in clinical practice	Qualitative Research

which is seen as unfavorable (Marakas & Hornik, 1996). According to Cenfetelli (2006), Resistance is defined as the user’s conscious thought to avert a system. Resistance is not as strong as non-adoption as it leaves the opportunity to future use.

Different theoretical models can be determined in order to understand the antecedents of consumer resistance of technology in Different services (Table 2). For Ram (Wallendorf et al., 1987), three group of factors can drive consumers to reject innovation: consumer characteristics (innovation perception, personality, attitudes, previous experience, motivations); innovation characteristics (relative advantage, compatibility, perceived risk, complexity); and characteristics of propagation mechanisms (credibility, clarity, source similarity and informativeness). Finally, Claudy, Garcia and O’Driscoll (2015) proposes that consumers resistance relies upon the context and the type of innovation.

Resistance Concept is a complex one and its determinants may differ due to the nature of service and the type of technology. Such an in-depth understanding requires more studies that accentuates on the determinants of doctors’ resistance to AI technologies in healthcare. No similar study has not yet been conducted in Tunisia and rarely in the world. Indeed, despite a rapidly increasing number of scientific publications related to the resistance of artificial intelligence in healthcare perceived by patients and stockholders, none have focused on the determinants of resistance perceived by Doctors’ (He and al., 2019; Watson and al., 2021). Exploratory study and specifically qualitative analysis can provide and identify such insights which are preceded by a theoretical basis to guarantee the required rigor and to provide the desired understanding (Müller et al., 2021).

4. METHOD

4.1 Research Design

An Exploratory research and specifically Qualitative research were adopted to identify and deeply understand the barriers of doctor’s adoption to artificial intelligence in healthcare based in their specific social contexts. Initially, relevant concepts were identified by examining the state of research in the context of technology Resistance. Based on that an interview guideline was developed. Subsequently, the recruitment of the interview participants and the execution of semi-structured individual interviews took place and finally the research was completed by coding and analyzing these interviews to identify factors explaining the resistance of doctors to AI in a healthcare context.

Table 2. Anterior research on barriers to technology adoption

Barriers to technology adoption	Nature of study	Reference	Focus
Perceived ease of use	Qualitative/ Focus groups	Laukkanen et al. (2008); Laukkanen (2016)	Patients with cardiological diseases AI devices
Complexity	Quantitative research	Kim et al. (2017)	Mobile learning
Fear of technology replacing human work	Quantitative research	Chemingui and Ben Lallouna (2013)	IoT devices in Healthcare
Trust	Qualitative/ Focus groups	Molesworth and Suortti (2002)	Online services: Buying cars online
Perceived Price	Qualitative/ interviews	ouzani et al. (2018)	Mobile health application
Perceived Health Risk	Quantitative research	Sovacool et al. (2017)	AI robots in surgery

4.2 Interview-Guideline

The interview guideline (Figure 1) ensured that respondents (Doctors) were given sufficient freedom to describe their experiences with and opinions regarding the barriers to AI adoption. This made it possible to more understand the existing factors of resistance from different theoretical models, but also to identify additional ones, which had not been considered previously. The interview guideline was designed as a semi-structured one as this format enables consistency across the different interviews and clarify unclear or ambiguous answers by asking questions (Bryman 2016; Myers 2010). We refined the guidelines based on two pilot interviews.

4.3 Interviews

Overall, 11 semi-structured interviews were conducted. We chose Doctors from different specialties as participants for our study because their perception is crucial for implementing such technologies in healthcare. Also, as mentioned in the theoretical part, no similar studies have been yet conducted in Tunisia and rarely in the world. They were addressed by email in order to arrange a meeting to discuss the barriers of AI adoption in healthcare. The interviews were contacted face-to-face at the participants' workplace and those who did not accept due to the pandemic of COVID-19, they were conducted by telephone. 11 Doctors from different specialties were interviewed.

Before the interview, a short introduction containing research objectives was presented. The questions were open-ended in order to allow doctors to share their opinions and thoughts, or even to deviate into other subjects that are not mainly connected to the initial question. Each interview took nearly 30 min and for recording, a digital voice recorder was used after their approval. Memos notes were also used during the interviews. The interview was divided into three sections: In the first section doctors explained how they perceived AI in general. In the second section they were asked about the influence of AI in healthcare. From there on, interviewees could express their perceived barriers of AI adoption in the Tunisian healthcare in the third section.

4.4 Interview Analysis

To systematically analyze and categorize the information from the interviews, qualitative content analysis was chosen to analyze and identify the determinants of doctors' resistance to AI using Computer Assisted Qualitative Data Analysis Software, QSR NVivo (version 12). After transcription and translation (by a professional translator) of the interview, relevant text segments were selected, and similar segments were extracted using coding. Thereafter, their hierarchical order was deliberated to present the interpretation of themes. As researchers, we moved back and forth between the transcribed interviews in its origin and text segments to guarantee that our interpretations of the data were in harmony with the context in which they arose during interviews (Table 3).

Figure 1. The interview guideline

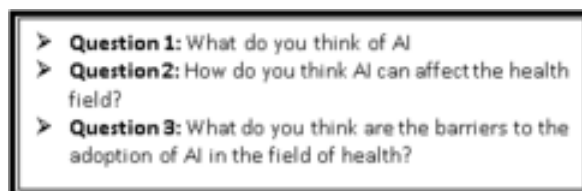


Table 3. The stepwise approach used for the data analysis (Torbjornsen and al., 2019)

Steps	Descriptions
Step 1	The entire data were read through to obtain an overview
Step 2	Text segments that were relevant to the research question were selected
Step 3	The text segments were sorted and coded
Step 4	The codes were categorized into themes and sub-themes
Step 5	The interpretations were confirmed by moving back and forth between the data segments and the context in which they arose during the interviews
Step 6	The themes were interpreted by applying a theoretic approach in accordance with the parameters of resistance models.

5. RESULTS

5.1 Participant Characteristics

Eleven Doctors were interviewed between Mars and Mai 2021, until saturation was observed. They are consisted of 3 cardiologists, 2 dermatologist, 1 oto-rhino-laryngologist, 1 Resident in general and digestive surgery, 1 resident in emergency, 1 gynecologist, 2 Resident in Cardiovascular Surgery. Their age was between 27- 45. Our participants were all Tunisians. 82% of participants were male and 18% were female. Table 4 summarizes these characteristics.

5.2 Themes and Sub-Themes

As our main objective is to understand in depth the barriers to Tunisian doctors’ adoption of Artificial Intelligence in healthcare, one main theme and 5 sub-themes were determined from the participants’ responses. The main theme is “resistance to AI” and sub-themes are the barriers of AI adoption. Furthermore, Doctors’ conception of AI was illustrated in a world cloud (Figure 2).

Our research revealed several barriers identified by Tunisian doctors that complicate the adoption of artificial intelligence in healthcare (Table 5). The barriers are as follows.

Table 4. Participant characteristics

No.	Specialty of doctors	Age	Gender	Nationality
1	Cardiology	35	Male	Tunisian
2	Cardiology	28	Male	Tunisian
3	Cardiology	40	Male	Tunisian
4	Dermatology	32	Female	Tunisian
5	Dermatology	36	Female	Tunisian
6	Oto-rhino-laryngology	29	Male	Tunisian
7	General and digestive surgery	29	Male	Tunisian
8	Gynecology	45	Male	Tunisian
9	Cardiovascular Surgery	28	Male	Tunisian
10	Cardiovascular Surgery	28	Male	Tunisian
11	Emergency	29	Male	Tunisian

5.2.1 Lack of Financial Resources

The major barrier that was identified across the 11 sub-themes is the lack of financial resources. The participants perceived artificial intelligence as an expensive technology and require an important financial resource and the Tunisian government cannot afford it as it is passing by a financial crisis.

5.2.2 Necessity for a Special Training

The second barrier that was identified from the study is the necessity for a special training. Majority of Tunisian Doctors expressed that artificial intelligence is a complex technology and applying it in medicine make it more complicated, so it necessitates a special training to know how to use it. Moreover, in order to exploit the full potential of AI, doctors should know how to effectively interpret AI results and how to use AI tools.

5.2.3 Perceived Cost

Artificial intelligence is perceived as an expensive technology that needs important financial resources to afford it. It is considered as a key barrier for AI adoption. Concerns were related to costs associated with equipment, infrastructure, and technical requirements for integration. Indeed, the infrastructure of the Tunisian healthcare that is required to implement AI remains inadequate.

5.2.4 Performance Risk

Another important barrier that has been determined from the study is Performance risk. Doctors explained that AI is like any technology has the possibility to malfunction and become incapable to reach the ultimate Goal. It can give the doctor false results or interpretation which may threaten the safety of patients and leads to injuries and even death.

Also, they think that Clinical experience remains the basis for diagnosis and treatment in medicine.

5.2.5 Technology Dependency

Our study has revealed that technology dependency is another factor for doctor's resistance to AI in healthcare. For participants, artificial intelligence will affect the training of doctors who will tend to rely on the results and interpretations of this technology and be dependent on it. In addition, it will affect a very interesting concept which is Learning by Clinical Reasoning (ARC). AI may damage the capacities of doctors, according to participants, as he becomes reluctant and stop trying to improve his knowledge in medicine.

According to the study, the doctor-patient relationship is considered as important and may be threatened with the implementation of AI in healthcare. Doctors perceive that their direct relationship with patients plays a vital role in the cure process. how-ever, with the implementation of AI, this relationship may diminish. They added that most of the doctors and even patients used to have a human contact in consultation or in surgery so they will probably refuse to be operated by a surgical robot for example.

5.2.6 Fear of AI Replacing Human Work

According to the participants, With the implementation of AI, there is a tendency to underestimate the role of the doctor because hospitals and clinics will have access to a technology that can reason like doctor and may exceed him. As a result, there is a fear that AI automation and robotics will eliminate job and may take the place of doctor and abandon his services.

6. DISCUSSION

The rapid evolution of Artificial intelligence in healthcare and its implementation in international hospitals and clinics, professional, ethical, and societal questions are imposed. Our main objective was to understand in-depth doctors' barriers to the adoption of AI in healthcare.

The results shows that doctors perceive AI as beneficial to the medical field and specially in diagnostic and prevention however the overall acceptance of AI implementation in healthcare is low due to several barriers which is not the same results as previous studies in different context and culture (Lai et al., 2020). Most of the barriers that were determined by the study are consistent with previous research and theoretical frameworks of innovation resistance. However the perceived importance of each barrier is different. The most important barrier that the study has revealed is the lack of financial resources. This result is consistent with Ram and Sheth theory (Wallendorf et al., 1987). The author suggests that high-tech technologies often require high financial resources which makes countries and specially developing countries reluctant and unwilling to spend such amount of money on these technologies.

The second barrier that was identified from the study is necessity for a special training. According to Benešová and Tupa (2017), to successfully implement high-technologies, specialized training and skilled healthcare personnel is vital to know how to use automated smart machines and take advantage of it. Applying technologies like Artificial intelligence in medicine can put human lives in danger. This makes the situation more sensible and requires to be treated carefully by training the workforce (Ajmera & Jain, 2019).

The third barrier that was identified is Perceived Cost. According to Lian and Yen (2013), consumer may not adopt a technology if the costs are perceived high. Cost can include equipment, infrastructure, and maintenance costs.

Moreover, Performance risk is determined as another barrier to AI adoption in healthcare. This result is consistent with Ram and Sheth theory (Wallendorf et al., 1987). Performance risk is defined as the uncertainty of the functionality of a technology due to its novelty (Wallendorf et al., 1987). In fact, when a technology is new, consumers and specifically doctors might be incapable to anticipate its overall performance, and this leads to resistance.

In addition, our study showed that dependency is perceived as a barrier to AI adoption. As AI may help doctors in diagnostic, prevention, and interpretation, they fear to become dependent to this technology. Also, they feel that using AI in their work reduces their autonomy (Mani & Chouk, 2018). According to Mani and Chouk (2017) automated machines can generate psychological and functional dependence, which may lead to a resistance reaction.

Furthermore, results revealed that need for human interaction is an important barrier to AI adoption. Dabholkar and Bagozzi (2002) defined the need for interaction as “The importance of human interaction to consumer in service encounters”. Technologies like AI in healthcare are able to do tasks autonomously without human intervention. Consequently, face-to-face communication between the doctor and patient will decrease which leads to doctor’s resistance as they perceive doctor-patient relationship is vital in the cure process and the lack of interaction with their patient is perceived negatively (Wallendorf et al., 1987).

Finally, fear of AI replacing human work is considered as a barrier to AI adoption in healthcare. According to Lapointe and Rivard’s (2005), doctors may resist automated machines when they feel that their jobs and their role as a doctor is being threatened as these technologies can work autonomously and can reason like human.

There is multiple implication of this study. First of all, To the best of our knowledge, this study is the first survey of Doctors’ barriers to AI adoption in the Tunisian healthcare. In addition, our research presents an in depth understanding of the consumer resistance theories. Moreover, one of the major issues for managers is to reduce doctors’ resistance and stimulate their acceptance to new services and thus avoid their failure. To resolve this issue, adoption barriers should be determined. Also, the research provides guidance for medical organizations about which barriers need to overcome to leverage the value of AI.

Despite the contribution that our study has made, some limitations were identified. First, the respondents pool was not representative in terms of gender (82% male and 18% female). Moreover, as our participant age was between 27-40, further research should concentrate on doctors above

40 years. Different age range may generate new barriers to AI adoption. Moreover, as our study concentrated on doctor's barriers, further studies should concentrate on patients and other healthcare personnel barriers. Finally, as our study is an exploratory one, further validation should be carried with a quantitative study.

7. CONCLUSION

AI tools are becoming important in the medical field day by day as it provide a high-quality health data and many other advantages. Tunisian Doctors point of view about AI was generally positive as they think that the application of AI in healthcare is extremely useful and beneficial. However, there are multiple barriers that prevent AI adoption which are: lack of financial resources, need for special training, performance risk, perceived cost, technology dependency, need for human interaction and fear of AI replacing of human work. However, the most important barrier that was identified by Tunisian doctors is “the lack of financial Resources” . Decision-makers should take these barriers into consideration to foster implementation of AI in healthcare. Indeed, The Tunisian health ministry believes it is a priority to review a national AI strategy. The state is already encouraging startups to get into this innovative field, and it is ready to fund publicly. According to a survey launched by the Ministry of Industry and SMEs, most civil servants (85%) are convinced of the benefits of AI for improving the services provided and lightening the currently complex and cumbersome procedures (Secteur public, n.d.).

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