

E-Health Implementation Challenges and HIS Evaluation in Accordance with EMRAM in Iran

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Abstract

The implementation of electronic health (e-Health) in healthcare organizations consistently encounters numerous challenges. These barriers hinder the widespread adoption of this promising technology within healthcare settings. This study addresses the challenges of implementing e-Health across various hospitals and also aims to evaluate the maturity of hospital information systems (HIS) in Iranian hospitals based on the electronic medical record adoption model (EMRAM). Through two rounds of literature review and case studies, a comprehensive understanding of these previously unexplored issues has been developed. The findings identify 13 social and technical challenges, including the lack of standard applications, high costs associated with e-Health and training, legal issues, security concerns, inconsistencies and diversities in perceived e-Health benefits and barriers, lack of proficiency, and difficulties healthcare professionals face in integrating e-Health into their daily tasks. There are also negative perceptions among physicians and patients regarding the use of e-Health software, the lengthy implementation times for HIS systems, technical difficulties due to platform diversity, resistance to change, and the limited use of pilot projects, particularly in Iran. Moreover, the maturity of hospital cases in Iran is at 3 stages, in contrast to the 7 stages of EMRAM. These results underscore the need to develop an effective strategy to address the challenges identified in this research. Additionally, a specific program should be implemented for developers to enhance the maturity of HISs and advance them to higher stages of EMRAM.

Keywords: Medical Informatics; Quality Assurance; Hospital Information System; Information System; Electronic Medical Records; Iran

1. Background

The digitization of the medical field began over 40 years ago under various names, including health information technology, health information systems, health informatics, and medical informatics (1, 2). These terms have since been collectively referred to as e-Health. Electronic health is regarded as a type of health quality improvement service aimed at enhancing the efficiency and effectiveness of healthcare delivery in medical centers (3). Currently, there is no universally accepted definition of e-Health worldwide (4). However, a comprehensive definition of e-Health encompasses the cost-effective and secure use of ICT in health-related fields, including healthcare services, health surveillance, health literature, health education, knowledge, and research (2, 5).

A promising future is envisioned for e-Health. Wang et al. have emphasized that e-Health capabilities can be cat-

egorized into six distinct areas: Organizational, technical, economic, clinical, patient-related, and professional issues (5). Ayat et al., along with other researchers, have highlighted several motivating incentives for adopting e-Health, such as business process rationalization, data availability, cost savings, coordination of health services, fraud prevention, online authorization, and protection of citizen privacy (2, 7, 8). Despite the significant benefits of e-Health technology, it remains underutilized (9), and several challenges have been cited, including the lack of standardization of e-Health applications and the time required to implement and accept e-Health systems (10, 11). There is considerable evidence of ineffective or unjustifiable use of e-Health for various reasons (2, 12).

Given these advantages and challenges, evaluating the maturity of hospital information systems (HISs) is cru-



cial. To address this, several different evaluation models have been proposed (13). The Healthcare Management and Information Systems Society (HIMSS) developed the electronic medical records acceptance model (EMRAM), a globally recognized HISs maturity assessment model. Electronic medical records acceptance model ranks hospitals on a scale from 0 to 7, representing a spectrum from fully traditional to fully systematic hospitals (14). This HIS maturity evaluation model is widely utilized in various countries, especially in Western countries (15).

Iran, a developing country, has implemented various initiatives in the field of e-Health (16), reflecting the interest of Iranian officials in advancing e-Health (17). One of the initial steps in the development of e-Health in Iran involved the use of management software in medical diagnostic laboratories. Subsequently, software for the basic management of patient admissions and accommodations in hospitals was introduced. Both the Ministry of Health and Medical Education and the Ministry of Cooperation and Social Welfare have taken special measures in this field, promoting electronic health in health-related activities. TAKFA stands out as one of the most advanced and comprehensive development programs in Iran's e-Health sector during the first decade of the 21st century (18). Additionally, other e-Health oriented projects such as SEPAS (meaning "thanks") have been implemented at both regional and national levels (19-21). After several decades, these programs and projects have significantly contributed to the quantitative and qualitative development of e-Health in Iran.

Despite numerous studies exploring the barriers to e-Health implementation in various countries, a comprehensive study specifically addressing these issues has not yet been conducted in Iran (2, 22-24). Research has also been carried out to evaluate the maturity of hospitals in countries like the Netherlands and the United States (15, 25); however, similar evaluations are still needed across different health sectors in Iran.

2. Objectives

Therefore, the two main objectives of this research are to identify the challenges of electronic health in Iran and to assess the EMRAM maturity in Iranian hospitals.

3. Methods

Initially, a search was conducted for all components comprising electronic health in various formats across different databases, including PubMed, Elsevier, Springer, Scopus, IEEE, Emerald, and other renowned repositories. These searches included terms such as health information technology, health informatics, and e-Health. Additionally, the word "Iran" was also used to find content specifically related to e-Health in Iran. In this way, in the first phase of this project, all the results from the compilation of projects related to e-Health globally and particularly in Iran were compiled.

Additionally, the evaluation of HIS is a major concern within the healthcare systems of all countries. The HIMSS Foundation (14) is a non-profit and globally recognized organization that has developed a widely accepted model for assessing the maturity of HIS in hospitals. The analytics provided by HIMSS are invaluable resources that empower and enhance decision-making within healthcare organizations. They encourage medical authorities to measure how effectively technologies are adopted and utilized to improve healthcare outcomes through their maturity evaluation model. According to (14), "the Electronic Medical Record Adoption Model (EMRAM) measures clinical outcomes, patient engagement, and physician use of EMR technology to increase organizational performance and health outcomes among patient populations". Furthermore, "EMRAM combines methodology and algorithms to rate the entire hospital, including inpatient, outpatient, and day care services provided on the hospital campus." Electronic medical record adoption model scores hospitals based on their e-Health maturity and offers a detailed roadmap to foster adoption and initiate a digital transformation journey toward desired outcomes. According to EMRAM, hospital organizations can be ranked from zero to seven. This eight-step EMRAM allows authorities and assessors to analyze a hospital's level of EMR adoption, chart their achievements, and track their progress against other healthcare organizations both nationally and globally. The widespread adoption of this model by hospitals in over 50 countries has led to its continuous refinement and enhancement. A full description of the model is available on the HIMSS website (14).

The second phase of this research focused on assessing the HIS maturity of Iranian hospitals. The two ministries, the Ministry of Health and Medical Education and the Ministry of Welfare and Social Security, oversee the health sector in Iran. However, the vast majority of hospitals in Iran are managed and supervised by the Ministry of Health and Medical Education. These hospitals, which serve a broad spectrum of patients, employ a large number of medical staff and are equipped with extensive medical facilities. Among these, some are among the most prestigious and largest hospitals in both the country and the Western Asian region, providing services to patients from both within and outside of Iran.

Iran is a Middle Eastern country comprising 31 provinces. In addition to Tehran, the capital, Iran has other major cities well-known both nationally and in the broader Middle Eastern and West Asian regions. Isfahan is one such province, with its capital, the city of Isfahan, recognized for its population, historical significance, and scientific importance. This city attracts special attention from both Iranian citizens and officials, as well as people from neighboring countries. Isfahan is home to renowned medical centers staffed by top doctors who provide services to both local and international clients. For these reasons, the hospitals selected for this study are located in Isfahan, drawing many patients from across the country and the region.

These hospitals are managed by the Isfahan University of Medical Sciences. While some hospitals exclusively treat patients, others also offer training for medical staff.

For this research, a selective sampling method was used to choose a number of hospitals under the supervision of the Isfahan Faculty of Medical Sciences. Accordingly, 5 hospitals met the criteria and were selected for this study. These hospitals are referred to as A to E, with their characteristics detailed in Table 1. Each hospital has a department responsible for e-Health programs and services, known

as the Information Technology Department, Computer Office, or Informatics Center. Each office is led by a chief information technology officer who ensures services are provided in accordance with the Service Level Agreement (SLA) of the hospital. Consequently, 5 individuals directly participated in this phase of the research. It is important to note that this is a qualitative study utilizing interview sessions to gather sufficient information to meet the research's objectives.

Table 1. The Specification of Selected Hospitals in Isfahan

Hospital	Name of Hospital	Number of Medical and Operational Users	Using Current HIS (y)	The Area of Expertise
1	A	1200	5	General
2	B	370	5	Orthopedics
3	C	261	3	Urology
4	D	154	2	Ophthalmology
5	E	231	2	General

The procedure for each hospital proceeded as follows: Initially, the model was generally introduced to each participant. Subsequently, the researcher clearly described each stage of the model and asked participants to identify the appropriate EMRAM stage for their hospital. Each interview session lasted between 40 and 65 minutes and was conducted in their respective offices.

Additionally, there was a need to validate the data obtained. For this purpose, eleven lecturers from Isfahan University of Medical Sciences were selected. These faculty members taught various subjects related to electronic health and hospital management. The selection of these senior lecturers and professors was advantageous because the hospitals under study were managed by this university, and the lecturers were familiar with the conditions of these five hospitals. Moreover, many of their students came from these hospitals, and students often discuss hospital matters with their professors. Therefore, these professors were well-informed about the cases

studied in this research and served as a valuable resource for evaluating the results. To assess the results, the EMRAM model was first presented to them, followed by the obtained results, allowing them to express their opinions about the findings.

4. Results

4.1. Challenges of Implementing Electronic Health in Hospitals Around the World, Particularly in Iran

As previously mentioned, e-Health encompasses a wide spectrum (26) and has the potential for further development in the future (4). Despite the extensive benefits discussed in this research, other studies have indicated that e-Health has not yet reached the expected levels of implementation (27, 28). During the first round of applying the key words of this research, challenges were extracted and listed in Table 2.

Table 2. Challenges for Electronic Health Implementation in the World, Particularly Iran

Row	Reasons	References
1	Lack of standardization of e-Health applications	22 - 24
2	Cost of e-Health	25 - 29
3	Training cost due to unfamiliarity of medical experts and other related educational issues	30, 31
4	Legal challenges related to information security and responsibilities	32 - 34
5	Privacy and security fears	35 - 41
6	Inconsistencies and diversities of e-Health benefits/barriers	42 - 44
7	Lack of proficiency and difficulties that healthcare professionals have in interacting with the e-Health in their daily tasks	45 - 48
9	Negative perceptions of physicians and patients about the use of e-Health systems	48 - 50, and 2
10	Time to implement and acceptance of e-Health systems	50 - 53
11	Technical difficulties with the diversity of platforms and the technologies	54 - 56, and 2
12	Resistance to change	54, 57 - 59
13	Pilot projects or small implementations with limited amount of patients	60 - 62

4.2. Electronic Medical Record Adoption Model Assessment Result

As noted earlier, different hospital cases have been selected for this research. The advantage of selecting diverse case studies, sometimes with different HIS, is to gain a multi-dimensional view of the coverage, position, and strategy of HIS in Iranian hospitals. Each hospital is known for at least one specialty. The experts interviewed revealed that various software products are used in the hospitals under study. In addition to HIS, other software components such as attendance and welfare systems, along with other modules sometimes developed by the Ministry of Health or the University of Medical Sciences, were also in use. Moreover, various HISs provided by relevant development companies were installed in selected hospitals based on the policies of the Ministry and the University of Medical Sciences. These HISs are among several different systems developed by competing companies in this field and available in Iran. It is important to note that due to the political and policy-making conditions in Iran and existing restrictions, no foreign systems are utilized in this field in Iran. The awareness of the respondents about the different HISs used in hospitals ensured that no significant disagreements were observed in the context of the cases studied.

However, the final findings from the HIS maturity assessment, based on interviews with the IT heads of these hospitals, are presented in Appendix 1.

5. Discussion

The initial part of this research focused on the challenges associated with electronic health both globally and within Iran. As indicated in Table 2, numerous research findings from various countries, including Iran, were identified and assessed. The researcher categorized these challenges based on thematic similarities, resulting in 13 distinct categories of challenges as derived from database searches. Notable challenges include “time to implement and acceptance of e-Health systems” (4 references), “lack of proficiency and difficulties that healthcare professionals experience when interacting with e-Health in their daily tasks” (5 references), “privacy and security concerns” (7 references), “resistance to change” (4 references), and the “cost of e-Health” (5 references), which have been frequently reported. Particularly, the interaction of medical doctors with this technology has been identified

as a significant challenge. Additionally, technical issues such as “security and privacy” (7 references) have also been frequently cited. It is significant to note that similar challenges identified in the research conducted in Iran mirror those found in other countries worldwide. In other words, many of the challenges highlighted in this research are also prevalent in Iran.

Additionally, as the second phase of this research, the maturity of HIS in Iranian hospitals was assessed using the EMRAM model and is presented in Appendix 1. According to this model, it was determined that all the studied hospitals have a minimum maturity level of 2 as per EMRAM standards. This means that these hospitals meet EMRAM expectations (14), which include aspects such as “Limited shared care plans outside the organization,” “Leverage 3rd party reference resources,” “Basic alerts are in place,” and “Some externally generated data incorporated into the patient record.” Other features like “Policies for Continuity of Care strategy, business continuity, disaster recovery, and security & privacy are in place,” “Data governance is active,” and “Patient record is available to multi-disciplinary internal and tethered care teams,” among others, are also present. Additionally, more advanced features like “Multiple entity clinical data integration,” “Regional/national PACS Electronic referrals, consent are in place,” and “Aggregated clinical and financial data” are attainable in these hospitals. However, “Telemedicine” has not yet been implemented in these hospitals, and “Mobile tech supports point of care” is only planned to be implemented in hospital case A, with no plans in the other cases. Interestingly, “Pandemic tracking and analytics is in place” only in hospitals A and E, and “All care team members have access to all appropriate data” is implemented solely in hospital A. In other words, hospital case A is more IT-equipped compared to the others. Nonetheless, the final maturity of these hospitals does not exceed the third stage of EMRAM.

According to Table 3 and the HIMSS society, which serves as a global advisor, the 6th and 7th stages of EMRAM are outlined for various countries (14). The association’s website indicates that most hospitals in Asian countries, including Iran and India, have not reached the seventh stage of EMRAM. Similarly, apart from some Arab countries like Saudi Arabia and UAE, the outlook in other countries is not promising (14). This finding underscores the need for a clear plan to meet the expectations of EMRAM across different countries.

Table 3. Electronic Medical Record Adoption Model Stage of Asian Countries Including Iran

Continental	Country	Stage 6	Stage 7
Asia	China	18	0
	India	0	0
	Thailand	1	0
	Iran	0	0

The results obtained were presented to eleven univer-

sity professors who were familiar with the conditions

and cases of the hospitals. They largely recognized the weaknesses and current statuses of these hospital cases. The interviewed professors believed that these hospitals, along with others providing services under the university's coverage, require increased investment to enhance their technological capabilities. Some emphasized the need for strategic thinking in this area and the creation of a comprehensive IT master plan to prevent resource wastage. Overall, they all acknowledged the low maturity of these hospital cases compared to the EMRAM standards.

5.1. Conclusions and Suggestions

Iran has initiated e-Health projects like SEPAS and TAK-FAB over the past few decades. In this context, various HISs developed by domestic software companies have been installed across multiple hospitals. According to the findings of this research, the challenges of implementing e-Health in Iran mirror those found in other countries. Thus, thirteen challenges in the field of e-Health implementation were identified and detailed in the research results. Furthermore, some of the hospitals investigated are among the most advanced in Iran. However, optimistically, they have not advanced beyond level 3 of the EMRAM model. This indicates that no hospital in Iran has yet reached levels 6 and 7 of the EMRAM model, and there is a considerable journey ahead to achieve such levels.

Given these challenges, the following suggestions are proposed for the long-term successful implementation of e-Health in Iranian hospitals:

- The two Ministries of Health, Medical Education, and Cooperation and Social Welfare are responsible for healthcare in Iran. Each ministry has undertaken developmental measures to establish the HIS in their affiliated hospitals. It was noted that the HISs used in hospitals managed by the Ministry of Health, Treatment, and Medical Education are not very mature. Additionally, there was no specific policy at the ministry level for selecting or developing such HISs. This lack of targeted development policy needs addressing. Therefore, one of the fundamental actions that should be taken is the establishment of an expert group for the planning and targeted development of HIS for hospitals under this ministry. As policymakers, this group should set the HIS development policy in Iran based on the requirements of the EMRAM.

- From this research, it was discovered that developers are not familiar with EMRAM and its requirements. Hospital information systems development companies should familiarize themselves with this non-profit organization based in Shanghai and align future developments with EMRAM standards. This approach will allow them to directly develop their modules to meet the expected maturity levels of EMRAM.

- All the information technology personnel in the studied hospitals were aware of the drawbacks of operating isolated systems within their hospitals. Issues such as redundant data entry and dissatisfaction among pa-

tients and their companions were noted. Additionally, there were problems with transmitting information to university and ministry managers and officials. Another challenge was the inability to exchange data between different active systems within the hospitals. The recommended solution is to implement a specific standard for generating and exchanging information between various systems in the hospital. A committee familiar with EMRAM-based policies could facilitate the creation of clear policies in HIS development and standardization of data development and exchange.

- All the hospitals under study had experienced viral attacks. Furthermore, IT managers in each hospital had devised their own makeshift solutions to close the computer ports to hospital employees. Despite strong physical security measures, a fundamental vulnerability exists in the cybersecurity of these hospitals. Increased focus is needed to safeguard these and other hospitals from cybersecurity threats.

- Resistance to change is a longstanding issue in the modernization of information technology-based systems within organizations. Medical staff, particularly doctors, are notorious for their resistance to IT changes. The most effective strategy is to conduct training sessions to increase understanding and familiarity with the use of information technology in hospitals. This issue is exacerbated when the existing information systems already fulfill the users' needs, leading them not to see the necessity for changes, thus initiating resistance. Employing experts in technology management could help mitigate such resistance.

- Adhering to EMRAM requirements is crucial in the development of electronic health systems globally. Attention to the requirements and approach of this model is essential in developing any e-Health system, especially as it is currently regarded as a benchmark for assessing the quality of hospital services in the field of health tourism.

5.2. Future Work

This research could be expanded to include other hospitals in Iran. Private hospitals and those under the Ministry of Cooperative, Labor, and Social Welfare may be considered for future studies. The results obtained could then be compared with the findings of this research.

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