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Research Article

Exploring the Digitalization of Hospitals Upon the EMRAM Model: The Case of Türkiye

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Abstract: Scarcity of resources, difficulties in service delivery, and demand for efficiency in healthcare services may be counted among the most prominent reasons for the digitalization of healthcare services, ultimately leading to the emergence of digital hospitals. In this sense, the present study attempted to reveal to what extent Ankara-based private hospitals comply with digital maturity criteria and the deficiencies of these hospitals for the Stage 7 digital excellence benchmark. While the target population consisted of Ankara-based private hospitals, we aimed to reach all hospitals within the population, and the officials of 17 hospitals agreed to participate in the study. The methodology of the research relies on the updated EMRAM criteria by HIMSS. We collected the data face-to-face from the authorized staff in the hospitals (e.g., information processing managers). The data were analyzed using the Microsoft Excel 2016 Office program. Based on the EMRAM criteria, we found out that six out of 17 participating hospitals could only be rated as Stage 0, one as Stage 1, three as Stage 2, and seven as Stage 3. However, no hospital could attain Stage 6 and Stage 7 achievements, the top levels for being accredited as a "digital hospital" by HIMSS. Overall, we can confidently assert that the information systems of the participating hospitals bear too many deficiencies to be accepted as digitalized. Such shortcomings may stem from the lack of investment, the hospitals' concerns for data protection, and the lack of user-friendly information technologies in these hospitals.

Keywords: Digital Hospital, HIMSS, EMRAM, Health Technology Assessment

1. Introduction

The concept of a digital hospital may be described as a medical ideal where daily operations and record-keeping are performed almost entirely by computers in the hospital (Weiss, 2002). The concept, therefore, anticipates radical transformations in medical care thanks to novel technologies and is thought to affect almost all aspects of healthcare delivery. For example, physicians can now share their expertise through video conferencing and other digital tools, thus guaranteeing the most appropriate care in the most convenient place. Moreover, nurses can engage in health information exchange (HIE) about patients in digital environments and ensure a smoother transition from hospital to home care. In addition, inventory management systems can shorten storage time and ensure on-time delivery of medical supplies (e.g., drugs and implants). Nevertheless, it should be noted that novel technologies appeal to novel threats (e.g., malware) that force healthcare organizations to halt or shut down their services temporarily. Thus, healthcare providers may need to consider such risks when embracing digitalization (Juhra, 2022).

Many studies in the literature reveal that hospitals that achieve high levels of Health IT improve the quality of care (e.g. lower mortality rates, reduce medical errors, improve patient safety and increase satisfaction), hospital efficiency and financial performance (e.g. lower costs, increased revenue and productivity) (Karahanna et al., 2019, p. 114; Agarwal et al., 2010; King et al., 2003).

According to a study conducted in 150 hospitals in the US in 2009, it was found that digital hospital applications made significant contributions to healthcare delivery. In this context, a 7% reduction in risk-based mortality rates, a 22% decrease in hospitalization times, a 40% improvement in average diagnosis time and a 60% increase in productivity were observed. In addition, various advantages such as acceleration of communication within the hospital, more efficient use of resources, reduced costs and

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saving archive space thanks to the use of paperless and filmless systems have been achieved (Ak, 2013, p. 974).

Digital hospital systems reduce the time doctors spend searching medical records, filling out forms and waiting for test results, resulting in a reduction of about 15% in their daily workload. In addition, the main advantages are that digital hospitals reduce healthcare costs and increase overall efficiency (Jiang & Zhang, 2004).

The Healthcare Information and Management Systems Society (HIMSS) should be referred to when mentioning a digital hospital. Founded in 1961, HIMSS offers a wide range of services to healthcare institutions worldwide with 600 affiliated companies and 450 associations/foundations. HIMSS, which is headquartered in Chicago and has several affiliated organizations in America and Asia, aims to introduce the most efficient utilization of information technologies in the delivery and development of healthcare services (HIMSS, 2021).

HIMSS Analytics, the research unit of HIMSS, has designed Electronic Medical Records Adoption Model (EMRAM) standards to determine the digitalization stages of hospitals. It was first introduced in 2005 for monitoring Electronic Medical Records (EMR) applications in hospitals and healthcare systems in the USA. Dividing a healthcare facility's EMR capabilities into eight maturity stages (see Table 1), HIMSS Analytics developed an exclusive scoring technique that describes the progression of the facility from a paper-based environment (Stage 0) to a digitized environment (Stage 7) (Pettit, 2013).

EMRAM has a significant role in reducing medical errors, improving efficiency and patient safety, and preventing redundant workflow of healthcare providers that cause undesirable health outcomes (Chen et al., 2013). The EMRAM model defines sequential, specific, and measurable technological checkpoints for healthcare providers. For example, closed-loop medication management requires the implementation of decision support software prior to deploying a barcode scanner that matches the prescription drugs and patients. In other words, a lower-level application may be needed for launching the primary application (Kharrazi et al., 2018)

Considering an unprecedented interest in the concept of a digital hospital worldwide, the present study aimed to reveal the EMRAM stages and digitalization-oriented deficiencies of Ankara-based private hospitals and offer relevant recommendations to contribute to their digitalization process.

Table 1

EMRAM Adoption Model Cumulative Capabilities

Stage	Cumulative Capabilities
Stage 0	All major ancillary clinical systems are installed
Stage 1	Ancillaries – laboratory, pharmacy, and radiology/cardiology information systems; picture archiving and communication system (PACS); digital non-DICOM image management
Stage 2	Clinical data repository (CDR); internal operability; basic security
Stage 3	Nursing and allied health documentation; electronic medication administration record (e-MAR inpatient); role-based authorization
Stage 4	Computerized provider order entry (CPOE) with CDS; nursing and allied health documentation; basic business continuity.
Stage 5	Physician documentation using structured templates; intrusion detection and prevention systems; mobile device protection
Stage 6	Technology-enabled closed-loop medication, blood products, and human milk administration; risk assessment and reporting; full clinical decision support (CDS) system
Stage 7	Complete EMR; external HIE; disaster recovery; privacy and security

2. Methods

The target population consisted of Ankara-based private hospitals. There were 37 private hospitals operating in Ankara during the research period (October 2021-March 2022). We then aimed to reach all hospitals within the population, and the officials of 17 (46%) hospitals agreed to participate in the study. In this cross-sectional field study, we collected the data using a questionnaire with EMRAM capabilities from the authorized staff in the hospitals face-to-face (e.g., information processing managers, administrative and financial affairs coordinators, human resources managers, and board members). The authorities of the hospitals that accepted to participate in the study were included in the study through their IT managers and completed the questionnaires by receiving support from other department coordinators during the data collection process for the relevant topics in the questionnaire form. In total, IT managers of 17 hospitals participated in the study. Participants were simply asked to rate whether capabilities are satisfied in their hospitals (Yes-No). The data were then analyzed using the Microsoft Excel 2016 Office program. As shown in Table 1, each EMRAM stage demands the fulfillment of specific requirements. The capabilities required in the stages are considered cumulatively; in other words, a healthcare institution needs to fulfill the requirements of the relevant stage and lower stages to be considered successful at the relevant stage.

2.1. Ethical statement

Before collecting the research data, the questionnaire to be applied was approved by the Hacettepe University Ethics Commission's ethics committee decision “13.04.2021 and numbered E-35853172-050.06-00001545387”. Data were collected online after ethics committee approval.

3. Findings

Table 2 presents the brief capabilities to be fulfilled at each stage - from Stage 0 where only basic clinical ancillaries (laboratory, pharmacy, radiology) are installed to Stage 7 where the hospital no longer uses paper and carry out functions in an electronically safe environment - and the results of the participating hospitals relative to the EMRAM capabilities. Accordingly, our findings showed that 7 (41%) hospitals (H2, H3, H5, H8, H15, H16, and H17) attained Stage 3, three (18%) hospitals (H6, H10, and H12) attained Stage 2, and one (6%) hospital (H4) reached Stage 1 of the EMRAM grading system. The remaining hospitals (35%) were found to remain at Stage 0.

The hospitals were found to have severe deficiencies to satisfy Stage 4 capabilities (Table 2). Thus, the hospitals were even nowhere near attaining Stage 6 or Stage 7, the benchmark stages for certification. Then, we list the hospitals’ shared deficiencies relative to EMRAM criteria as follows:

- Digital non-DICOM image management (Stage 1)
- CDS within basic conflict control systems (gender, duplication control transactions) (Stage 2)
- Integration of e-MAR and nursing documentation with CDR (Stage 3)
- Electronic personnel records (99%) and CPOE in the emergency department (Stage 4)
- Computerized preparation, implementation, and reporting of nursing documentation and business plans. Advancing IT security (Stage 5)
- Advanced CDS (Stage 6)
- Digitalization of patient files and physician documentation (at least 90%) and closed-loop medication management (95%) (Stage 7)

Tablo 2

EMRAM Ratings of the Hospitals

Stage	Capabilities	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17
7	Complete EMR; external HIE; data analytics; disaster recovery; privacy and security; paperless hospital	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	Technology-enabled closed-loop medication, blood products, and human milk administration; risk assessment and reporting; full CDS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	Physician documentation using structured templates; intrusion detection and prevention systems; mobile device protection	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	CPOE with CDS; nursing and allied health documentation; basic business continuity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	Nursing and allied health documentation; e-MAR; role-based authorization	X	✓	✓	X	✓	X	X	✓	X	X	X	X	X	X	✓	✓	✓
2	CDR; internal operability; basic security	X	✓	✓	X	✓	X	✓	✓	X	✓	X	✓	X	X	✓	✓	✓
1	Ancillaries; PACS; digital non-DICOM image management	X	✓	✓	✓	✓	X	✓	✓	X	✓	X	✓	X	X	✓	✓	✓
0	Only major ancillary clinical systems (laboratory, pharmacy, and radiology/cardiology) are installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: ✓: Satisfying the capability; X: Not satisfying the capability

4. Discussion

According to the EMRAM scoring system, Stage 3 was found to be the highest stage that the participating hospitals could attain. Our findings suggested that the hospitals yielded some shortcomings in satisfying the maturity requirements in the EMRAM model.

In a study with five healthcare institutions in Hebron, Palestine, the researchers found out that three attained EMRAM Stage 3 while the remaining had Stage 2 and Stage 1 digitalization, respectively (Najar et al., 2021) Another EMRAM rating study with three healthcare institutions in Isfahan, Iran showed that only two hospitals exhibited the EMRAM Stage 2 capabilities, and the other had Stage 1 digitalization (Ayat and Sharifi., 2016). In a comprehensive study with 848 hospitals in China, the findings yielded that 260 (30.7%) hospitals were rated as Stage 0, 102 (12.0%) as Stage 1, 269 (31.7%) as Stage 2, 188 (22.2%) as Stage 3, 23 (2.7%) as Stage 4, 5 (0.6%) as Stage 5, and 1 (0.1%) as Stage 6. The authors found out that none of the participating hospitals attained EMRAM Stage 7 (Shu et al., 2014). Overall, it can be asserted that the hospitals in Iran and China have Stage 2 and Stage 3 digital maturity. In the study conducted with the participation of 13 health institutions in the state of Victoria in Australia, it was stated that only 1 hospital achieved EMRAM level 7 rating (Bonello et al., 2021)

In Türkiye, among the participating 600 state hospitals, 36.83% were rated as Stage 2, 6.83% as Stage 3, 8.67% as Stage 4, 11.67% as Stage 5, 35.83% as Stage 6, and 0.17% as Stage 7 (Kose et al., 2020). In this study, more than half of the participating hospitals (52.33%) could be rated as Stage 4 and below. A report released in Germany in 2019 revealed the mean EMRAM scores of different countries/regions in 2017. Accordingly, the scores were found to be 2.3 for Germany, 2.3 for Austria, 3.6 for European Union (EU), 3.7 for the United Kingdom, 3.8 for Türkiye, 3.9 for Spain, 4.8 for the Netherlands, 5.3 for the USA, and 5.4 for Denmark (Klauber et al., 2019). Overlapping our findings, these results suggested that EMRAM scores of hospitals in the EU and some countries are often concentrated between Stage 2 and Stage 4, which may be due to deficiencies in the information system infrastructure of private healthcare institutions.

On the other hand, the previous research reported that 30% of Dubai hospitals attained EMRAM Stage 5 or higher between 2011 and 2016 (El-Hassan et al., 2017) and that the rate of EMR utilization increased from 15.1% in 2010 to 58.1% in 2018 in Korean hospitals and from 21% in 2008 to 53% in 2014 in Japan hospitals (Kim et al., 2017; Kanakubo and Kharrazi, 2019). Similarly, while the rate of American hospitals with Stage 4 and higher digitalization maturity was less than 4% in 2004, it was boosted to about 6% in 2008, about 20% in 2010, about 38% in 2012, and about 68% in 2014 (Kharrazi et al., 2018).

There are many reasons for the low level of EMRAM ratings of private health institutions. It is thought that one of the reasons for this low level is the funds allocated to the public health sector by international organisations and the government. When the activity cost tables in the 'Performance Programme' reports published by the Ministry of Health are examined, it is seen that there is no funding for the concept of 'digital hospital' yet, but in many countries around the world, governments provide many funds for the digitalisation processes of health institutions. In the USA, the Health Information Technology for Economic and Clinical Health (HITECH) law in 2009 allocated approximately 3 billion US dollars to accelerate the use of EHR in US hospitals. As a result, EHR use in US hospitals increased from 9.4% in 2008 to 96% in 2017 (Henry et al., 2016; Liang et al., 2021). Since 2015, the Chinese Central Government has invested over USD 3.5 billion in HIT and EHRs. It has issued 31 national policies and 134 technical standards covering all aspects of the digitalisation of medical care and the construction of a digital medical security system (Liang et al., 2021).

Apart from funding, it is seen that technical standards also create problems for hospitals in transition to higher levels. The fact that EMR requirements do not support the clinical workflow challenges healthcare organisations in transition to higher levels. In addition to this, the lack of a data warehouse within the boundaries of the health institution is another problem for hospitals. The requirement for a complex information technology structure in the transition to higher levels is another situation that prevents healthcare organisations from progressing to higher levels (Augustine et al., 2022).

5. Conclusion and Recommendations

Overall, we discovered many shortcomings in the information systems of the participating hospitals for digitalization. Considering the relevant literature, although the said hospitals attempted not to fall behind the trend of technological developments according to the EMRAM criteria, the majority were able to satisfy only the requirements set for lower stages. This picture may be related to their inability to keep up with complex information technologies, financial difficulties (investment and funding), and the challenging nature of the cumulative progress of the EMRAM criteria.

It should also be noted that implementing digitalization in healthcare institutions may require a prolonged and compelling process. Attaining digital maturity and deserving accreditation at the relevant EMRAM stages (Stage 6 and Stage 7) may take up to one year. Thus, the inability to organize such a preparation process before participating in this study can be cited as another reason why the mentioned

hospitals remained at lower EMRAM stages. In line with our findings, below are our recommendations for the participating hospitals to eliminate the shortcomings to be able to attain higher EMRAM stages:

- Healthcare institutions should
    - deploy applications that will enable patient-centric digital storage of non-DICOM images,
    - install core conflict control systems for lower stages within CDS and adopt a digital-based five tried-and-true principles supported by barcode and data matrix systems for higher stages,
    - implement e-MAR and integrate nursing documentation into CDR,
    - keep nursing and allied documentation mostly in an electronic environment (90%),
    - utilize CPOE in the emergency department,
    - prioritize applications for disconnections or data deletion in case of loss or theft of portable devices,
    - ensure a paperless working environment for the highest stage,
    - employ core teams to manage the digitalization process.
- The government should
    - introduce relevant policies to encourage private healthcare institutions to digitalization,
    - target the dissemination of health information systems with investment and funding incentives in the private health sector,
    - undertake periodic supervision of private hospitals for digitalization to shape digitalization-oriented policies.

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