e-Health Care Development in Saudi Arabia: Challenges and Problems in e-Health Systems

Fuhid Alanazi
Faculty of Engineering and Information Technology
University of Technology Sydney, Australia

Valerie Gay
Faculty of Engineering and Information Technology
University of Technology Sydney, Australia

Abstract

This systematic review aimed to identify the challenges and problems facing e-health in Saudi Arabia. This information is essential for subsequent identification of e-health modelling requirements and e-health opportunities in the country. A search in Google Scholar using the topic as the search term generated 19 papers for review. The results are presented as abstracted findings of each paper (Supplementary Material) and categorisation by topic, type, and research methods. Analysis of the tabulated data showed that 10 papers dealt explicitly with the topic of this review, that is, problems, challenges and barriers in e-health. The remaining 9 addressed other topics, but included discussion of barriers, problems or challenges. There were 8 conference papers and 11 journal articles. Surveys (10) were the most frequently used (10) research method. Some studies used more than one method. In relation to specific problems, barriers or challenges, 29 papers discussed technological issues, 20 were related to ICT infrastructure and 13 identified organisational and psychosocial factors. This report discusses these results and makes three recommendations.

Keywords: e-Health in Saudi Arabia, e-Health care development, e-Health challenges & problem.

Introduction

Although Saudi Arabia has made significant progress with respect to health care, including international recognition for some of its hospitals, it has been slower to develop its e-health system (Altuwaijri, 2008). The slow implementation of e-health in Saudi hospitals has been attributed to a lack of coordination (Almalki, FitzGerald, & Clark, 2011). It has been suggested that identification of the e-modelling requirements of healthcare may provide at least a partial solution to this problem (Alanazi & Gay, 2020). However, this would not be sufficient, as not all the problems and challenges have been fully documented. The research reported in this paper aimed to address this gap in knowledge of the problems and challenges of e-health requirements modelling in the Saudi healthcare system, with particular focus on lack of coordination as a major problem.

Methodology

The topic of this review—"emerging challenges and opportunities in modelling e-health systems requirements in Saudi Arabia"— was employed as the exact search term in the first five pages of Google Scholar using the 'any time' specification. The search was repeated for another five pages of Google Scholar with a time specification of 2015 to the present to locate more recent research. The search yielded 19 useful papers, including some abstracts containing relevant information. Papers that did not list or discuss problems and/or challenges and those not related to Saudi Arabia were not included. A recheck of papers listed in Google Scholar with different time frames showed that no paper related to the topic had been omitted.

Results

This section summarises the findings of individual papers.

Alnuem, Samir, Youssef, and Emam (2011) focused on the problems of integration and security, including a brief discussion of the unique patient identifier and the difficulties involved in integrating patient healthcare records from different providers. The authors proposed a model for integration.

Al-Solbi and Mayhew (2005) reported a general lack of awareness of the usefulness of ICT, the absence of a comprehensive national strategic plan for ICT development, absence of regulations to clearly define privacy, concerns about security for the organisation and individuals, and lack of ICT skills and advanced technologies, particularly an ICT plan and adequate funds for e-health.

Alharbi, Atkins, and Stanier (2015) identifed the main problems as high cost, complexity, and shortage of ICT skills. They proposed a framework for cloud computing decision making in the e-health sector of Saudi Arabia.

Uluc and Ferman (2016) identified ICT infrastructure, regulations, cultural and clinical adaptation of users, financing, and supply chain management as some of the major challenges in e-health development in Saudi Arabia and three other countries in the Middle East.

Alshamari and Seliaman (2014) noted that a majority of staff working in public and private hospitals in Saudi Arabia had either no experience or less than one year's experience in health information systems. This is a major problem, and it will be challenging to train all of them within a short time to speed up e-health development.

Alsulame, Khalifa, and Househ (2015) identified organisational and cultural issues, end-user attitudes and lack of required skills as the major challenges of e-health implementation in Saudi Arabia.

Hasanain, Vallmuur, and Clark (2014) presented a detailed review of barriers to implementing electronic medical records in Saudi hospitals as reported by different workers. The main concerns were around cost, privacy, software complexity, lack of uniform standards, inadequate vendor support and maintenance, and lack of knowledge and experience in using computers. The authors identified three categories of barriers: social, technical and resources. Social barriers included resistance to use of the system, language difficulties, the workloads associated with electronic medical records, physicians' attitudes, insufficient organisational support, and difficulty in using EHR. Physicians reported negative attitudes due to the time required for entering data in the computer, which reduced the time available for seeing patients, leading to a loss of productivity. This problem was more serious among physicians with lower levels of computer literacy. Technical barriers were related to unreliability of EMR vendors, lack of standardised nationally integrated systems due to the absence of a national regulator, complexity of the EMR system, security concerns, lack of a universal patient identifier system and absence of regular evaluation of EMR. The resource barriers reported were lack of appropriately skilled personnel, insufficient supply of the required computers and other technological resources. The authors also provided a chronological table of e-health implementation in Saudi Arabia, which is reproduced in Figure 1.

Chikhaoui, Sarabdeen, and Parveen (2017) observed that security, privacy, reliability, integration and data portability were the most critical barriers to the use of cloud computing in e-health applications in Saudi Arabia. They identified these factors as the reason for its slow adoption in Saudi Arabia.

Altuwaijri (2008) identified economic, technical, organisational and behavioural barriers to the implementation of e-heath in Saudi Arabia. These correspond to the barriers listed by Hasanain, Vallmuur, and Clark (2014).

Aldosari (2014) observed that, although the adoption rate for EHR systems in Saudi Arabia was comparable with those in developed countries, there were wide variations among hospitals with respect to the levels of adoption of individual

items. The pace of adoption was affected by weaknesses arising from the legacy of paper-based data and the enormous workload involved in the digital transformation of these data and maintenance process like updating and maintaining software and communication and exchange of information.

Year	*Sector*	*Action*	*Ref.*
1988	MOH	First introduction of EMR systems in Saudi Arabia.	(4)
1993	KFSH&RC	First introduction of HIS and record health related information electronically	(4)
1993	MOH	Telemedicine and Internet technology was introduced in Saudi Arabia.	(4)
1993	KFSH&RC	Developed an e-health centre.	(23)
1999	NGHA	The first IT strategic plan for implementing HIS was developed for the NGHA hospitals.	(42)
2000	MOH	A reform committee was formed to review the Saudi healthcare services, and highlighted the lack of appropriate HIS.	(20)
2001	MOH	An information technology strategic plan was developed based on the reform committee's recommendations.	(20)
2001	NGHA	The hospital purchased a commercial EMR system to be implemented in all NGHA hospitals.	(42)
2004	NGHA	System was operational in Riyadh site.	(42)
2005	KAU-HS / NGHA	Commencement of a two year Master program in health informatics.	(20)
2006	KAU-HS / NGHA	The Saudi Association for Health Informatics was developed and its first conference was conducted.	(10)
2007	Ministry of Defence & Aviation	The north-western region of Tabuk Armed Forces hospital had its first operational EMR system within all Armed Forces hospitals in Saudi Arabia.	(43)
2008	MOH	1 billion US dollar was allocated for e-health development and implementation in Saudi Arabia.	(25)
2008 - 2010	NGHA	In 2008, the NGHA started to implement EMR system in other sites, and was fully implemented and became operational in all four NGHA sites in 2010.	(42)
2010	NGHA	the Arab Health Conference awarded the NGHA the Middle East Excellence Award in electronic health records	(42)
2011	MOH	An Information and Communication Technology (ICT) team was assigned to develop a 10 year e-health strategic plan to improve the Saudi healthcare system and its services.	(18)
2011	MOH	The percentage level of EMR system implementation in 19 MOH hospitals, in the Eastern province of Saudi Arabia was identified to be 15.8%	(29)
2012	MOH	The level of EMR system implementation in 22 MOH public hospitals was: 11 hospitals had fully implemented EMR system. 8 hospitals had EMR implementations were in progress.	(28)

Figure 1. The chronology of implementation of EHR in Saudi Arabia (Hasanain, Vallmuur, & Clark, 2014).

Alaboudi, Atkins, and Sharp (2015) noted that the continuously increasing demand for healthcare in Saudi Arabia had led to a critical shortage of healthcare-related human resources and facilities. These problems were more serious in rural and remote areas. Telemedicine, which was introduced by the Ministry of Health in 2013 in collaboration with Canadian Health Infoway to address this problem, faced numerous challenges, namely, lack of coordination among different regional zones and directorates, limited application of telemedicine modalities, lack of infrastructure and knowledge about the services and benefits of telemedicine, difficulty of application of telemedicine, and resistance by healthcare personnel. These challenges were categorised into those requiring solution at the national level or facility level.

El-Mahalli, El-Khafif, and Al-Qahtani (2012) identified the lack of knowledge about telemedicine among healthcare professionals as the greatest barrier to its successful implementation in the Eastern Province of Saudi Arabia.

El Mahalli (2015) reported a range of problems that accounted for high levels of under-utilisation of most functionalities of the EHR system in Eastern Province, Saudi Arabia. These were: frequent loss of connectivity of the system when a computer crashes or the power fails, leading to temporary loss of access to the data; tight functions in utilising system, additional time required for data entry; lack of support from the hospital's IT staff to provide continuous training; difficulty in customising the system to meet users' needs; technological complexity, disruption to communication between doctor and patient; and lack of conviction about the benefits of EHR.

Al Taisan and Seliaman (2018) identified technical issues, performance expectancy and effort expectancy as barriers to the adoption of health information systems and EHR in the public hospitals of Alhasa city.

Khalifa (2013) identified six types of barriers as perceived by healthcare

professionals in public and private hospitals in Saudi Arabia: human (beliefs, behaviours and attitudes); professional (among different healthcare providers); technical (use of computers and IT); organisational (hospital management); financial (funding constraints); and legal and regulatory barriers. Of these, human and financial barriers were the most serious.

From a review, Binobaid, Fan, and Almeziny (2016) identified technical, semantic and organisational barriers to the implementation of pharmacy automation in Saudi Arabia, which has wider implications for automation of health information systems in Saudi Arabia. Organisational barriers were: resistance to change, lack of training, lack of financial support and shortage of professional human power. Semantic barriers were: mapping issues, workflow design change to reflect HIT needs, and inter-operability and information exchange. Technical factors were: inadequate IT support and maintenance, system complexity, security, confidentiality and privacy, lack of standards and poor quality of IT infrastructure. One hospital case study found that nurse-to-pharmacy phone communication did not facilitate documentation. There was no medication tracking system to check any misreading of the prescription by the pharmacist, contributing to medical errors. There was a limit on the number of possible patient drug profiles; exceeding this limit resulted in loss of documentation of patient medication records. This problem was exacerbated by the absence of a clinical intervention documentation system for patients. Other problems included: absence of a medical inventory management system to connect the pharmacist with the HIS; pharmacists' inability to use imaging systems to prioritise prescriptions; inadequacies in cancel discharge coding; and manual reading of CPR medication charts for children.

Almuayqil, Atkins, and Sharp (2016) undertook a detailed survey of 43 health professionals, 117 Saudi citizens and 41 IT professionals to rank their perceptions and experiences of e-health barriers. The results are summarised in Figure 2,

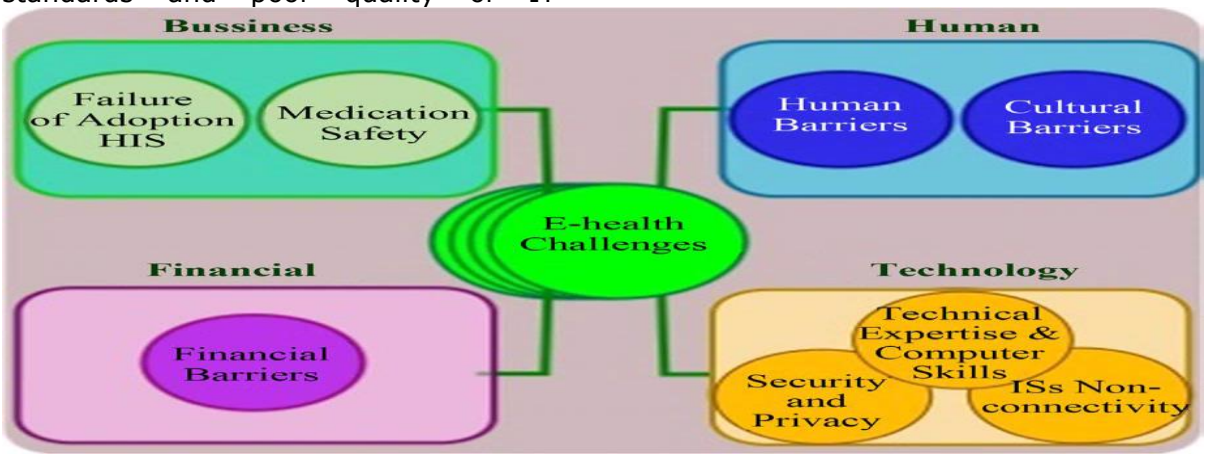

Figure 2. Perceived e-health barriers in Saudi Arabia (Almuayqil, Atkins, & Sharp, 2016).

where the main e-health challenges are categorised into business, human, financial and technological barriers. The authors' list of specific barriers is reproduced here as Figure 3, according to their perceived importance among different segments of e-heath users. For example, failure to adopt HIS in hospitals was not a concern for citizens but was perceived as a barrier by healthcare professionals and IT specialists. IT specialists were not concerned about human and cultural barriers.

Table 1. Areas of study-barriers to e-health.

Areas of study	Sub-factors	Citizens	Healthcare professionals	IT specialists
Non-connectivity of ISs	Lack of national healthcare system	√	√	√
Technical expertise and computer skills	Interface design, guidelines, experience in computer applications, access and maintenance	√	√	√
Failure of adoption of HISs	Planning, technical support and running over time/cost		√	√
Human barriers	Negative believes, lack of trust and resistance to change	√	√	
Cultural barriers	Human interaction	√	√	
Meciation safety	Limited use of technology and communication gap		√	√
Financial barriers	Financial barrier	√	√	√
Security and privacy	Easy to access patients' medical records	√	√	√

Figure 3. Perceived barriers among different categories of e-health users (Almuayqil, Atkins, & Sharp, 2016).

The responses of each category of users were analysed separately. Medication safety was not generally an issue for any category, although the mean was higher (3.7) for the IT specialists than for healthcare professionals (2.5). IT specialists perceived limited use of technology as a more important barrier (mean 4.2) than communication (mean 3.4). Among healthcare professionals, the means were much lower for limited use of technology (2.7) and communication gap (2.5). Separate graphs of the results are reproduced in Figures 4-6. Among citizens (Figure 4), the three highest ranked barriers were connectivity to information systems (mean 4.0), human barriers (mean 3.9) and financial barriers (mean 3.7).

All rankings among healthcare professionals (Figure 5) were lower than those of citizens. The three highest ranked barriers were: connectivity (mean 3.5), cultural barriers (3.1) and security and privacy (mean 3.0).

The IT professionals (Figure 6) ranked all of the barriers lower than both healthcare professionals and citizens. The three highest ranked barriers among the IT group were medication safety (mean 3.7), financial barriers (3.5) and connectivty to the information system (3.1).

These results were somewhat unexpected, and might be due to methodological issues. For instance, it might have been inappropriate to ask the same questions of all three groups, given their different perspectives on the issue. More valid results might have been obtained by conducting a survey of citizens and interviewing healthcare and IT professionals, given the relatively small number of responses (less than 50) in the latter two groups.

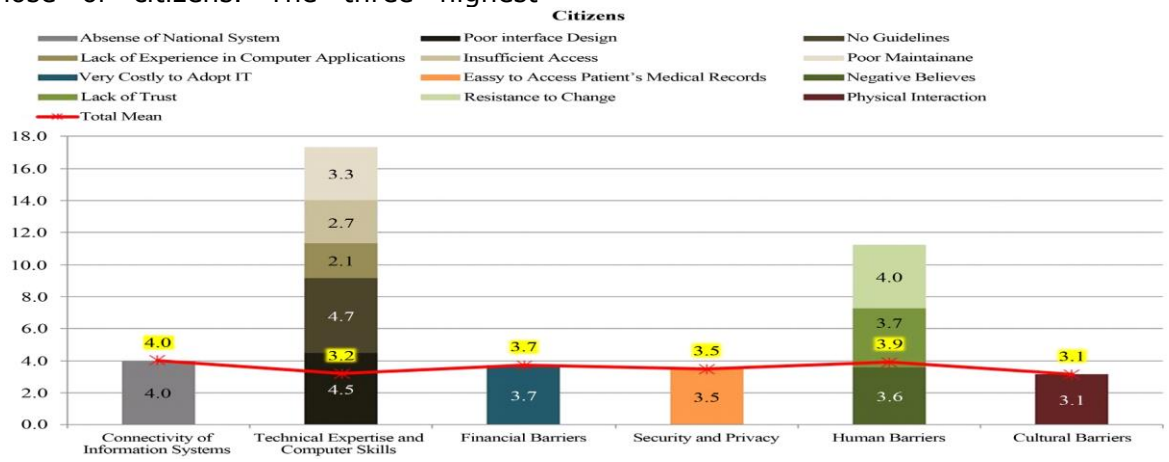

Figure 4. Survey responses of citizens (Almuayqil, Atkins, & Sharp, 2016).

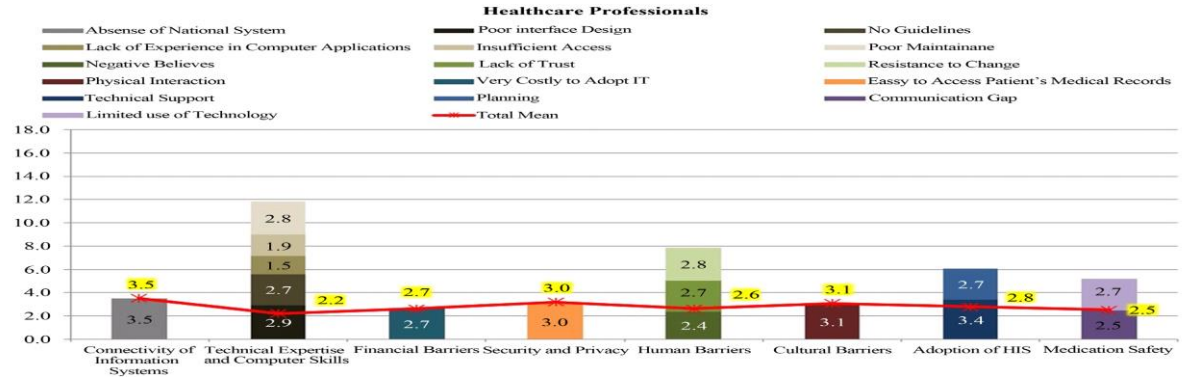

Figure 5. Survey responses of healthcare professionals (Almuayqil, Atkins, & Sharp, 2016).

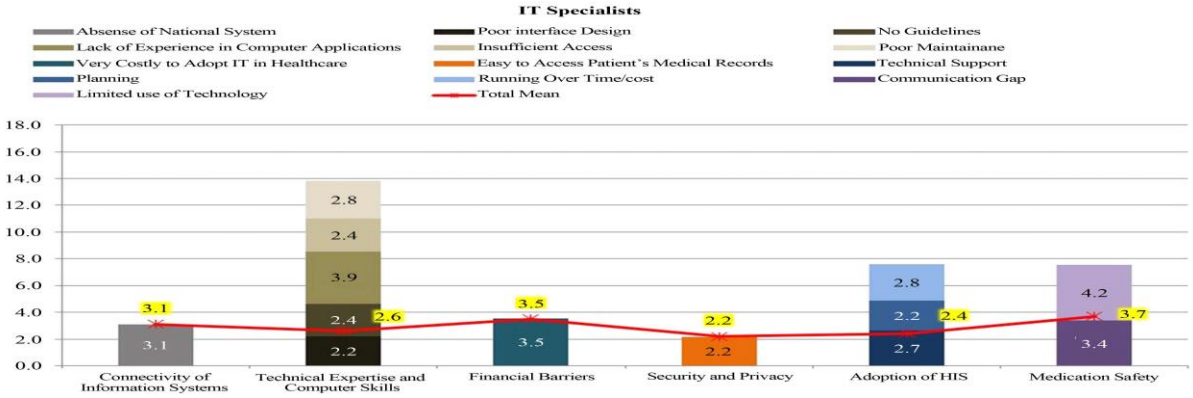

Figure 6. Survey responses of IT professionals (Almuayqil, Atkins, & Sharp, 2016).

Aldosari (2017) identified a variety of threats (barriers) to the adoption of health ATMs in Saudi Arabia: lack of coordination; lack of knowledge and experience in the area; lack of high level support; lack of regional references and experience in the area; absence of a national data warehouse and of a unified national health documentation system along with related legal/regulatory standards; security and network infrastructure in rural areas; management problems resulting from frequent changes in MOH leadership; lack of dedicated authority for health ATM; shortage of competent professionals to maintain e-healthcare systems; and potential customer resistance due to lack of awareness.

Alaboudi, et al. (2016) examined barriers to the adoption of telemedicine among Healthcare Facilities (HCF) decision makers in Saudi Arabia, basing their analysis on the Unified Theory of Acceptance and Use of Technology (UTAUT), the Technology–Organisation–Environment (TOE) theoretical framework, and the Evaluating Telemedicine Systems Success Model (ETSSM). They identified three main barriers: lack of adequate financial support to implement, operate, and maintain the telemedicine system; failure to align telemedicine services with the core mission, vision and needs; and constraints on the HCF around reimbursement for telemedicine services.

Alharbi (2018) described e-health in Saudi Arabia as follows: "an inadequate, partially dysfunctional HIT infrastructure further weakened by each implementation failure; a dire shortage of suitably-qualified Health Information Management (HIM) professionals, incapable or reluctant to train application users, let alone additional staff members in their own department; the failure to have implemented Health Data Standards, in accordance with International Organization for Standardization specifications".

A summary of the findings from individual articles is provided in appendix.

Comparative Analysis

This section presents the results of a comparative analysis of the selected

articles. An overview of the results is presented in Table 1.

Table 1. Common Themes in the Reviewed Papers

Topic of paper	***Number***	***Remarks***
Papers dealing directly with problems and challenges	10	Any problem mentioned or discussed in the article.
Other	9	
Type of paper	***Number***	***Remarks***
Conference papers	8	
Journal articles	11	
Research methods	***Number***	***Remarks***
Review	5	
Survey	10	
Interviews	4	
Case studies	1	
Other	3	Mostly models and frameworks.
Total	23	Total is higher than the number of papers because some papers used more than one method.

Of the 19 papers reviewed, 10 dealt directly with the review topic. In the remaining nine, the review topic was discussed but was not the main focus of the study.

Eight of the 19 papers were conference papers, and the rest (11) were research articles. In the case of two papers (12 and 16), it was not clear from the bibliographical entries to which category they belonged, so one was assigned as a conference paper and the other as a journal article.

Surveys were the most commonly used research method, followed by reviews and interviews. There was one case study. Some studies used more than one method, so the total is greater than 19.

Content analysis identified nine broad types of barriers discussed in the papers. In some cases (items 5 and 8), the same barrier was identified by different stakeholders (IT professionals, users and healthcare professionals). These were counted as three separate reports, so the total number of reports exceeds 19. Thus, there were 29 reports of lack of resources, funding, technology, skills, experience and training. In the case of ICT infrastructure and various operational problems, 20 reports were counted. Lack of awareness was specifically mentioned on only one occasion. There was frequent mention of organisational and psychosocial problems (13).

Table 2. Categorisation of barriers

No.	***Barrier***	***No. of papers***	***Remarks***
1	Integration/coordination/alignment	5	All levels
2	Security, privacy, confidentiality and regulations	8	
3	Lack of awareness of any type at any level	1	
4	Lack of comprehensive national strategy/plan/standards/policy/laws/regulations etc.	8	
5	Lack of resources, funding, technology, skills, experience and training	29	Including supply chain management, rural and remote areas, telemedicine, customisability, proper documentation and control
6	High cost	2	
7	Complexity	7	Including ease of use, telemedicine
8	ICT infrastructure and operational problems	20	Including telemedicine, frequent loss of connectivity
9	Organisational and psychosocial problems	13	Including vendor support, digitisation of paper records

Discussion

The findings indicated that numerous problems and challenges exist in how e-health is currently implemented in Saudi Arabia. This has serious implications for its ability to meet the health targets established in its Vision 2030 strategic plan (Saudi Arabia, 2016).

The three main challenges are related to the most important aspects of e-health implementation in any country, namely, resources, ICT infrastructure, and organisational and psychosocial factors.

First, adequate resources in the form of funding, technology, skills, experience and associated training are vital components of any successful implementation of e-health. The lack of HIT skills needed to implement e-health projects in a short space of time can be rectified only by an accelerated training programme involving universities and other professional institutions.

Second, it is vital to develop ICT infrastructure to ensure fast and uninterrupted connections throughout the country, including remote areas, to prevent data loss. Although internet coverage in Saudi Arabia is comparable to that in developed countries, problems in connectivity continue to be experienced in rural and remote areas, which are the very areas with the greatest need for e-health systems like telemedicine, since they lack access to specialist hospitals for serious health conditions. Partial or total failure of e-health projects exacerbates this problem.

Data portability, inter-operability, communication and sharing of information are all essential for the integration and coordination necessary to ensure that any patient anywhere can access healthcare even if the original record is kept in a specific hospital. The high degree of complexity of e-health systems was identified as a serious barrier by many authors.

Psychosocial barriers are also significant. Passivity or resistance on the part of stakeholders, negative perceptions of the technology, and concerns about privacy, security and confidentiality can all impact negatively on e-health implementation. These problems could be ameliorated by future developments in cloud computing and blockchain technology. In an Islamic country like Saudi Arabia, barriers also exist in the form of religious and cultural traditions. The support of religious leaders will need to be obtained to address these issues.

Like other countries, Saudi Arabia lacks appropriate national policies, strategies, laws and regulations for e-health. Although some countries have adapted ISO standards or follow some WHO guidelines, there are as yet no international standards specifically for e-health. Saudi Arabia should be encouraged to appoint a team of experts to develop e-health standards for the country, as has occurred in the USA and UK.

Conclusions

It is not surprising that the desired level of success in e-heath implementation has not been achieved in Saudi Arabia, given the number of problems, challenges and barriers identified by different researchers. Although further work is clearly necessary, much can be accomplished using existing knowledge effectively.

To this end, three recommendations are made here. First, universities and other research institutions should be involved in training healthcare professionals in e-health to address the skills shortage in this area. Second, cultural barriers can be addressed by enlisting the support of religious leaders. Third, an expert committee should be formed to develop Saudi e-health standards which can form the basis of policies, strategies, laws and regulations for successful implementation of e-health in Saudi Arabia. These strategies are especially important if the ambitious health targets of Vision 2030 are to be achieved.

Limitations

The review was limited to research in Saudi Arabia. Additional insights might have been obtained by including work from other countries.

Only five web pages, each with any time and 2015 and beyond, were searched in

Google Scholar. The review could usefully be extended by searching more pages.

References

1. Al Taisan, E. A., & Seliaman, M. E. (2018). Perceived Barriers and Drivers of Health Information Systems Adoption by Public Hospitals in Alhasa. *21st Saudi Computer Society National Computer Conference (NCC), 25-26 April 2018, Riyadh, Saudi Arabia* (pp. 1-5). IEEE. doi:10.1109/NCG.2018.8593111
2. Alaboudi, A. A., Atkins, A., & Sharp, B. (2015). A Holistic Framework for Assisting Decision Makers of Healthcare Facilities to Assess Telemedicine Applications in Saudi Arabia. *eTELEMED 2015 : The Seventh International Conference on eHealth, Telemedicine, and Social Medicine* (pp. 203-208). IARIA. Retrieved December 10, 2019, from http://eprints.staffs.ac.uk/2184/1/Alaboudi%20paper%20lisbon%202015.pdf
3. Alaboudi, A., Atkins, A., Sharp, B., Balkhair, A., Alzahrani, M., & Sunbul, T. (2016). Barriers and challenges in adopting Saudi telemedicine network: The perceptions of decision makers of healthcare facilities in Saudi Arabia. *Journal of infection and public health, 9*(6), 725-733. doi:10.1016/j.jiph.2016.09.001
4. Aldosari, B. (2014). Rates, levels, and determinants of electronic health record system adoption: A study of hospitals in Riyadh, Saudi Arabia. *International journal of medical informatics, 83*(5), 330-342. doi:10.1016/j.ijmedinf.2014.01.006
5. Aldosari, B. (2017). Health ATMs in Saudi Arabia: A Perspective. *Acta Informatica Medica, 25*(2), 130–135. doi:10.5455/aim.2017.25.130-135
6. Alharbi, F., Atkins, A., & Stanier, C. (2015). Strategic framework for cloud computing decision-making in healthcare sector in Saudi Arabia. *The seventh international conference on ehealth, telemedicine, and social medicine, TELEMED 2015. 1*, pp. 138-144. IARIA. Retrieved January 31, 2019, from https://www.researchgate.net/profile/Fawaz_Alharbi5/publication/297380576_Strategic_Framework_for_Cloud_Computing_Decision-Making_in_Healthcare_Sector_in_Saudi_Arabia/links/56deab4308ae46f1e9a0e257.pdf
7. Alharbi, M. A. (2018). The Status Quo of Health Information Technology and Health Information Management Efficiency in Saudi Arabia: A Narrative Review. *International Journal of Health Research and Innovation, 6*(1), 11-23. Retrieved December 11, 2019, from https://www.researchgate.net/profile/Musaed_Alharbi2/publication/325281035_The_Status_Quo_of_Health_Information_Technology_and_Health_Information_Management_Efficiency_in_Saudi_Arabia_A_Narrative_Review/links/5b0371230f7e9be94bdaccff/The-Status-Quo-of-Hea
8. Almalki, M., FitzGerald, G., & Clark, M. (2011). Health care system in Saudi Arabia: an overview. *Eastern Mediterranean Health Journal, 17*(10), 784-793. Retrieved October 29, 2019, from https://apps.who.int/iris/bitstream/handle/10665/118216/17_10_2011_0784_0793.pdf
9. Almuayqil, S., Atkins, A. S., & Sharp, B. (2016). Ranking of E-Health barriers faced by Saudi Arabian citizens, healthcare professionals and IT specialists in Saudi Arabia. *Health, 8*(10), 1004-1013. doi:10.4236/health.2016.810104
10. Alnuem, M., Samir, E.-M., Youssef, A., & Emam, A. (2011). Towards integrating national electronic care records in Saudi Arabia. *International Conference on Bioinformatics & Computational Biology (BIOCOMP'11), The 2011 World Congress in Computer Science, Computer Engineering, and Applied Computing (WORLDCOMP'11), Las Vegas, Nevada, US-July* (pp. 777-783). Department of Information Systems, King Saud University, Riyadh, KSA. Retrieved December 8, 2019, from https://www.researchgate.net/profile/Ahmed_Youssef57/publication/299560165_Towards_Integrating_National_Electronic_Care_Records_in_Saudi_Arabia/links/56fed1df08ae650a64f72720/Towards-Integrating-National-Electronic-Care-Records-in-Saudi-Arabia.pdf
11. Alshamari, M. A., & Seliaman, M. E. (2014). Modeling the Determinants of Medical Information Systems Usability in Saudi Arabia. *ACHI 2014 : The Seventh International Conference on Advances in Computer-Human Interactions* (pp. 347-350). IARIA. Retrieved December 8, 2019, from https://www.researchgate.net/profile/Mohamed_Seliaman/publication/263046037_Modeling_the_Determinants_of_Medical_Information_Systems_Usability_in_Saudi_Arabia/links/00b7d539a00be92fb3000000.pdf
12. Al-Solbi, A., & Mayhew, P. J. (2005). Measuring e-readiness assessment in saudi organisations preliminary results from a survey study. *From e-government to m-government*, 467-475. Retrieved December 8, 2019, from https://www.researchgate.net/profile/PJ_Mayhew/publication/250758687_Measuring_E-Readiness_Assessment_in_Saudi_Organisations_Preliminary_Results_From_A_Survey_Study/links/0deec53bfababb97dd000000.pdf
13. Alsulame, K., Khalifa, M., & Househ, M. S. (2015). eHealth in Saudi Arabia: Current Trends, Challenges and Recommendations. In J. Mantas, A. Hasman, & M. S. Househ (Ed.), *13th annual International Conference on Informatics, Management, and Technology in Healthcare (ICIMTH 2015), Athens, Greece, in*

July 2015 (pp. 233-236). IOS Press. doi:10.3233/978-1-61499-538-8-233

14. Alanazi, F., and Gay, V. 2020. "e-Health for Diabetes Self-Management in Saudi Arabia: Barriers and Solutions," *Proceedings of the 36th International Business Information Management Association Conference (IBIMA)*, ISBN: 978-0- 9998551-5-7, 4-5 November 2020, Granada, Spain
15. Altuwaijri, M. M. (2008). Electronic-health in Saudi Arabia. *Saudi medical journal, 29*(2), 171-178. Retrieved December 8, 2019, from https://s3.amazonaws.com/academia.edu.documents/50821166/benefits_of_ehealth.pdf?response-content-disposition=inline%3B%20filename%3DElectronic-health_in_Saudi_Arabia_Just_a.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F2019
16. Altuwaijri, M. M. (2008). Electronic-health in Saudi Arabia. Just around the corner? *Saudi medical journal, 29*(2), 171-178. Retrieved October 29, 2019, from https://europepmc.org/abstract/med/18246222
17. Binobaid, S., Fan, I.-S., & Almeziny, M. (2016). Investigation Interoperability Problems in Pharmacy Automation: A Case Study in Saudi Arabia. *Procedia Computer Science, 100*, 329 – 338. doi:10.1016/j.procs.2016.09.166
18. Chikhaoui, E., Sarabdeen, J., & Parveen, R. (2017). Privacy and security issues in the use of clouds in e-health in the Kingdom of Saudi Arabia. *Vision 2020: Innovation Management, Development Sustainability, and Competitive Economic Growth 2016, I-Vii*, 1574-1589. doi:10.5171/2017.369309
19. El Mahalli, A. A. (2015). Electronic health records: Use and barriers among physicians in eastern province of Saudi Arabia. *Saudi Journal for Health Sciences, 4*(1), 32. doi:10.4103/2278-0521.151407
20. El-Mahalli, A. A., El-Khafif, S. H., & Al-Qahtani, M. F. (2012). Successes and challenges in the implementation and application of telemedicine in the eastern province of Saudi Arabia. *Perspectives in health information management/AHIMA, American Health Information Management Association, 9*(Fall), 1f. Retrieved December 10, 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3510649/
21. Hasanain, R., Vallmuur, K., & Clark, M. (2014). Progress and challenges in the implementation of electronic medical records in Saudi Arabia: A Systematic Review. *Health Informatics- An International Journal (HIIJ), 3*(2), 1-14. doi:10.5121/hiij.2014.3201
22. Khalifa, M. (2013). Barriers to health information systems and electronic medical records implementation. A field study of Saudi Arabian hospitals. *Procedia Computer Science, 21*, 335-342. doi:10.1016/j.procs.2013.09.044
23. SaudiArabia. (2016). *Vision 2030*. Saudi Arabia. Retrieved December 17, 2018, from https://vision2030.gov.sa/en
24. Uluc, C. I., & Ferman, M. (2016). A comparative analysis of user insights for e-health development challenges in Trukey, Kingdom of Saudi Arabia, Egypt and United Arab Emirates. *Journal of Management Marketing and Logistics, 3*(2), 176 - 189. doi:10.17261/Pressacademia.2016219945

Appendix

Reference	Problems and challenges	Remarks
Alnuem, Samir, Youssef, & Emam (2011)	Integration issues, security, and uniqueness of the patient identifier in integrating patient healthcare records from different providers.	Integration in a single national platform.
Al-Solbi & Mayhew (2005)	General lack of awareness about the usefulness of ICT, lack of a comprehensive national strategic plan for ICT development, absence of regulations to clearly define privacy, organisational and individual security issues, lack of ICT skills and of advanced technologies, absence of a specific ICT plan and adequate funds for e-health	E-readiness of KSA in healthcare.
Alharbi, Atkins, & Stanier (2015)	High cost, complexity, shortage of ICT skills.	Cloud computing as solution.
Uluc & Ferman (2016)	ICT infrastructure, regulations, cultural and clinical adaptation of users, financing, supply chain management.	Also evident in 3 other countries in the Gulf region.
Alshamari & Seliaman (2014)	Healthcare staff lack experience in health information systems. Training in a short time is a challenge.	Implementation problems.
Alsulame, Khalifa, & Househ (2015)	Organisational and cultural issues, end-user attitudes and lack of required skills.	Implementation problems.
Hasanain, Vallmuur, & Clark (2014)	Cost, privacy concerns, complexity of software as well as a lack of uniform standards, inadequate vendor support and maintenance, and lack of knowledge and experience in using computers. Social barriers included resistance use of the system, language difficulties, the workloads associated with electronic medical records, physicians' attitudes, insufficient organisational support, and difficulty in using EHR. Physicians reported negative attitudes due to the time required for entering data in the computer, which reduced the time available for seeing patients, leading to a loss of productivity. . This problem was more serious among physicians with lower levels of computer literacy. Technical barriers were related to unreliability of EMR vendors, lack of standardised nationally integrated systems due to the absence of a national regulator, complexity of the EMR system, security concerns, lack of a universal patient identifier system and absence of regular evaluation of EMR. The resource barriers reported were lack of appropriately skilled personnel, insufficient supply of the required computers and other technological resources.	Detailed review of barriers and challenges. Chronological table of e-health implementation in KSA.
Chikhaoui, Sarabdeen, & Parveen (2017)	Security, privacy, reliability, integration and data portability are the main challenges for cloud computing.	Leads to slow adoption.
Altuwaijri, Electronic-health in Saudi Arabia (2008)	Economic, technical, organisational and behavioural barriers.	
Aldosari (2014)	Weaknesses arising from the legacy of paper-based data and the enormous workload involved in the digital transformation of these data and maintenance protocols like updating and maintaining software and communication and exchange of information.	Rates, levels, and determinants of electronic health record system adoption: A study of hospitals in Riyadh, Saudi Arabia.
Alaboudi, Atkins, & Sharp (2015)	Critical shortage of healthcare-related human resources and facilities, especially in rural and remote areas. At national and facility levels, lack of coordination among different regional zones and directorates, limited application of telemedicine modalities, lack of infrastructure and knowledge about the services and benefits of telemedicine, difficulty of application of telemedicine and resistance by healthcare personnel.	Telemedicine solution has also not worked well.
El-Mahalli, El-Khafif, & Al-Qahtani (2012)	Lack of knowledge about telemedicine among healthcare professionals.	Telemedicine implementation problems.
El Mahalli (2015)	Frequent loss of connectivity of the system when a computer crashes or the power fails, leading to temporary loss of access to the data, tight functions in utilising system, additional time required for data entry, lack of support from the hospital's IT staff to provide continuous training, difficulty in customising the system to meet users' needs, technological complexity, disruption to patient-doctor communication, and lack of conviction about the benefits of HER.	High levels of underutilisation of EHR in hospitals in Eastern Province.
Al Taisan & Seliaman (2018)	Technical barriers, performance expectancy and effort expectancy influenced adoption of HIS and EHR	Alhasa.

Khalifa (2013)	Six types of barriers as perceived by healthcare professionals in public and private hospitals in Saudi Arabia: human (beliefs, behaviours and attitudes); professional (among different healthcare providers); technical (use of computers and IT); organisational (hospital management); financial (funding constraints); and legal and regulatory barriers of laws, regulations and legislations. Of these, human and financial barriers were the most serious.	Field study of private and public hospitals.
Binobaid, Fan, & Almeziny (2016)	Technical, semantic and organisational barriers to the implementation of pharmacy automation in Saudi Arabia. Organisational barriers were: resistance to change, lack of training, lack of financial support and shortage of professional human power. Semantic barriers were: mapping issues, workflow design change to reflect HIT needs, and inter-operability and information exchange. Technical factors were: inadequate IT support and maintenance, system complexity, security, confidentiality and privacy, lack of standards and poor quality of IT infrastructure. Nurse-to-pharmacy phone communication did not facilitate documentation. There was no medication tracking system to to check any misreading of the prescription by the pharmacist, contributing to medical errors. There was a limit on the number of possible patient drug profiles; exceeding this limit resulted in loss of documentation of patient medication records. This problem was exacerbated by the absence of a clinical intervention documentation system for patients. Other problems included: absence of a medical inventory management system to connect the pharmacist with the HIS; pharmacists' inability to use imaging systems to prioritise prescriptions; inadequacies in cancel discharge coding; and manual reading of CPR medication charts for children.	Single hospital case study.
Almuayqil, Atkins, & Sharp (2016)	The barriers were categorised into business, human, financial and technological barriers and sub-categorised according to three types of users. Medication safety was not an issue for any type of user. Medication safety was not generally an issue for any category, although the mean was higher for IT specialists than other healthcare professionals. IT specialists perceived limited use of technology as a more important barrier than communication. Among healthcare professionals, the means were much lower for limited use of technology and communication gap. Among citizens, the 3 highest ranked barriers were connectivity to information systems, human barriers and financial barriers. All rankings among healthcare professionals were lower than those of citizens. The 3 highest ranked barriers were: connectivity, cultural barriers and security and privacy. The IT professionals ranked all of the barriers lower than both healthcare professionals and citizens. The three highest ranked barriers among the IT group were medication safety, financial barriers and connectivty to the information system.	Very detailed study with many explanatory diagrams, tables and graphs. Survey of health professionals, Saudi citizens and IT professionals to rank the e-health barriers according to their perceptions and experience.
Aldosari (2017)	Identified a variety of threats (barriers) to the adoption of health ATMs in Saudi Arabia: lack of coordination; lack of knowledge and experience in the area; lack of high level support; lack of regional references and experience in the area; absence of a national data warehouse, unified health documentation at the national level, related legal/regulatory standards, security, and network infrastructure in rural areas; management problems resulting from frequent changes in MOH leadership; lack of dedicated authority for health ATM; shortage of competent professionals to maintain e-healthcare systems; and potential customer resistance due to lack of awareness.	Health ATMs.
Alaboudi et al. (2016)	Identified 3 main barriers to the adoption of telemedicine: lack of adequate financial support to implement, operate, and maintain the telemedicine system; failure to align telemedicine services with the core mission, vision and needs; and constraints on the HCF around reimbursement for telemedicine services.	Barriers to telemedicine adoption among HIF decision makers in Saudi Arabia. Analysis based on the Unified Theory of Acceptance and Use of Technology (UTAUT), the Technology–Organisation–Environment (TOE) theoretical framework, and the Evaluating Telemedicine Systems Success Model (ETSSM).
Alharbi (2018)	Described e-health in Saudi Arabia as follows: "an inadequate, partially dysfunctional HIT infrastructure further weakened by each implementation failure; a dire shortage of suitably-qualified Health Information Management (HIM) professionals, incapable or reluctant to train application users, let alone additional staff members in their own department; the failure to have implemented Health Data Standards, in accordance with International Organization for Standardization specifications".	Quote is from the abstract.