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Abstract

Purpose – Recent studies indicated that the level of adoption of health data standards in healthcare organisations remains frustratingly low worldwide although health data standards have been perceived to be an essential tool for interoperability barriers within health information systems. The relevant literature still lacks significant studies concerning the issues of the adoption process of health data standards in healthcare organisations, and in particular those in developing nation. In addressing this gap in knowledge, the purpose of this paper is to investigate the adoption decision of health data standards in tertiary healthcare organisations in Saudi Arabia, and to develop a technology-organisation-environment list that contains the critical factors influencing their adoption.

Design/methodology/approach – A multiple-case study methodology was conducted in Saudi Arabia and different data collection methods were used included semi-structured interviews with different decision makers at various levels and departments of the subject organisations, and documents analysis to identify critical factors to the adoption decision of health data standards.

Findings – The findings demonstrated a list of key factors from different aspects impacting the adoption decision of health data standards in the subject organisations. The technological factors are complexity and compatibility of health data standards, IT infrastructure, switching costs, market uncertainties, systems integration and enhancing the use of advanced systems. The main organisational factors are the lack of adequate policies and procedures and information management plan, resistance to change, data analysis and accreditation. The core environmental factors are the lack of national regulator and data exchange plan, national healthcare system and the shortage of professionals.

Research limitations/implications – The results from the qualitative data were difficult to generalise to other populations. For example, the structure of the health sector varies from country to country as each health sector has its own characteristics that affect and are affected by national circumstances. In order to provide a more grounded theory resulting from a qualitative study, further examination by conducting quantitative studies is required. In addition, the TOE approach does not take into account the sociotechnical issues and further research is required in this area.

Practical implications – The investigation into the adoption decision of health data standards in tertiary healthcare organisations in Saudi Arabia has led to the development of a technology-organisation-environment list that contains the critical factors influencing their adoption. The research outcome has addressed the gap in knowledge of the adoption of health data standards in healthcare organisations. It also provides the decision maker, and in particular those in developing nations, with better understanding of the adoption process of those standards to better judge and to develop suitable strategy of adoption interventions.

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Originality/value – Although recent studies indicated that the level of adoption of health data standards in healthcare organisations remains frustratingly low, the prior studies related to health data standards missed out on the exploration of the adoption decision of different types of health data standards in healthcare organisations and the critical factors influencing their adoption. Research on health data standards adoption based out of a developing country such as Saudi Arabia can also potentially provide several new insights on standards practices.

Keywords Saudi Arabia, Case study, Adoption, Health data standards, Health information systems
Paper type Research paper

1. Introduction

Owing to interoperability barriers between health information systems, there are potential limitations facing healthcare organisations with regards to acquiring the benefits of those systems and, in particular those associated with the safety, quality and cost of medical services (Kahn *et al.*, 2014; Chaudhry *et al.*, 2006). However, the level of interoperability that allows a "mix-and-match" environment requires a high degree of consensus on the health data standards (Tenenbaum *et al.*, 2014; Hammond, 2005). Even though health data standards are expected to be the basis for interoperability solutions (Kahn *et al.*, 2014; Berler *et al.*, 2006), the level of adoption of those standards remains frustratingly low (Kruse *et al.*, 2014; Olsen and Baisch, 2014; Deutsch *et al.*, 2010; Lin *et al.*, 2010; Smith *et al.*, 2008; Braa *et al.*, 2007; Zhang *et al.*, 2007; Jacucci *et al.*, 2006; Hammond, 2005; Bates *et al.*, 2003). Venkatraman *et al.* (2015) raised two main issues related to medical data quality worldwide. First, a big portion of the medical data are produced and stored in an unstructured format. Second, there is huge variety in the type of the collected data between healthcare facilities. The literature exposed that the proliferation of standards is somewhat overlapping and conflicting, resulting in market confusion and leading to increasing proprietary interests amongst the users and vendors of health information systems (Tenenbaum *et al.*, 2014; Hammond, 2005). The uncertainties within the market of health data standards can be one of the explanations for the low rate of adoption of health data standards in healthcare context today.

However, prior studies exposed that the literature still lacks significant studies concerning the adoption of health data standards in healthcare organisations (Olsen and Baisch, 2014; Lin *et al.*, 2010). Olsen and Baisch (2014) in their comprehensive review of the literature concerning health information systems and related medical data standards stated that there were few publications specifically describing the use of standards in healthcare organisations and there was little evidence that this was occurring. The primary adoption phase of innovation at organisational level is related to the decision-making process when the initial knowledge of and certain attitudes towards an innovation is formed and developed until the final decision either to adopt or reject the innovation is undertaken (Rogers, 1995). The actual decision is referred to those in authority in organisations since they have the control on the constraints and mechanisms to carry out the different activities required in the adoption process (Thomas *et al.*, 2008; Gallivan, 2001).

To date, there have been no studies that present a comprehensive empirically set of factors influencing the adoption decision of health data standards in healthcare organisations. Rather, the prior limited studies, where they do exist in this regards, focused only on a specific standard mainly Health Level Seven (HL7) version 2 and then based on the traditional adoption theories, such as Rogers' (1995) paradigm, generated, using a quantitative survey methodology, broad, general factors that would predict the adoption decision making of that standard across the hospitals (Lin *et al.*, 2010).

Rogers's (1995) model identified five generic innovation characteristics that are considered to influence the adoption process, these include:

(1) relative advantage: it is the degree to which potential adopters perceive the innovation as superior to existing substitutes;

(2) compatibility: it refers to the degree to which potential adopters feel the innovation is consistent with their present needs, values and practices;

(3) complexity: it implies to the degree to which the innovation is easy to understand or use;

(4) trialability: it is the degree to which the innovation is experimented with on a limited basis; and

(5) observability: it refers to the degree, to which the innovation's benefits or attributes can be observed, imagined or described to the potential adopters.

The outcome of the traditional adoption studies, such as Rogers' (1995) paradigm was limited for different main reasons. For example, the outcomes of traditional theories were successful only when applied to a narrow range of adoption scenarios, for example, if the adoption was at an individual level and the technology did not require extensive specialized knowledge before the adoption (Gallivan, 2001; Fichman and Kemerer, 1995). Researchers on the adoption of a complex IT innovation at organisational level were recommended to either abandon or integrate the traditional theories of an innovation adoption with such new approaches to fit the complex scenarios of an innovation adoption (Gallivan, 2001; Fichman and Kemerer, 1995). For example, another important stream of theory conducted in the literature for understanding IT-related standards adoption is the Economics of Standards (Thomas *et al.*, 2008; Hovav *et al.*, 2004; Markus *et al.*, 2003). The economic perspectives of standards focus on an innovation's inherent economic value for the potential unit of adopters (Thomas *et al.*, 2008; Hovav *et al.*, 2004).

Two essential theories have been used within the economic perspective of standards, namely, network externalities and switching costs. The network externalities theory describes a positive correlation between the number of users of an innovation and the utility of the innovation (Katz and Shapiro, 1986). The network externalities are predicated on the belief that the benefits of adopting an artefact are correlated to growth in the size of the community of adopters (Hovav *et al.*, 2004). Various methods could improve the size of the community of adopters such as a decrease in cost, an increase in usage experience and an increase of compatible products (Hovav *et al.*, 2004). The switching costs theory refers to a standard-specific investment that makes organisations hesitant to change to the required standard although the standard is seen to be superior on the basis of objective criteria (Hovav *et al.*, 2004). Several reasons were identified behind this issue, such as an adopter may be unwilling to bear the transient incompatibility, the risk of being locked into an artefact before it reaches a critical mass, or the sunk costs resulting from the presence of a large installed base of existing technology (Hovav *et al.*, 2004).

The IT innovation adoption studies also suggested that the researchers should not ignore the temporal aspects or neglect such important aspects (e.g. technology, people and the organisation) of the adoption process (Ancker *et al.*, 2014; Thomas *et al.*, 2008; Kamal, 2006; Fichman, 2004; Hu *et al.*, 2002). For example, the Tornatzky and Fleischer's (1990) framework was seen by a large portion of innovation adoption

studies as the most suitable framework for understanding technology adoption in an organisational context (Thomas *et al.*, 2008; Chang *et al.*, 2006; Chen, 2003; Hu *et al.*, 2002). This framework explained that an organisation's technology adoption decision can be jointly explained by a fairly three comprehensive dimensions, the technological, organisational and environmental contexts, known as TOE. The technological context is essentially described by depicting the important attributes of the technology. The organisational context is depicted by descriptive measures concerning the organisation (e.g. scope, size and managerial structure) and is influenced by formal and informal intra-organisational mechanisms for communication and control. The resources and innovativeness of the organisation also play a role. The environmental context refers to the different attributes of the external world in which an organisation operates. However, TOE is simply taxonomy for categorising constructs influencing the decision making in IT innovation adoption, and does not represent a well-developed theory (Thomas *et al.*, 2008).

Another reason is that a richer framework for understanding adoption decisions can be only developed through a qualitative study of cases adopting such standards (Ancker *et al.*, 2014; Thomas *et al.*, 2008; Dedrick and West, 2003). The quantitative surveys are intended only to make a priori assumptions of what constitutes a factor, and then set out to locate, measure and observe it (Vishwanath and Scamurra, 2007). Research on health data standards adoption based out of a developing country such as Saudi Arabia can also potentially provide several new insights on standards practices. Therefore, the purpose of this study is to develop, based on TOE taxonomy, a comprehensive, empirically set of factors influencing the adoption decision of health data standards in the main six tertiary healthcare organisations in Saudi Arabia. In doing so, the remainder of the paper is structured as follows. The next two sections give a background to the health data standard and the healthcare systems in Saudi Arabia which is the context of this study. Afterwards, the research methodology is discussed. Later, the key findings and discussion are explained. The authors conclude by presenting the main issues and contribution raised by the study.

2. Health data standards

Health data standards' industry has the potential to increase quality whilst, at the same time, lowering costs and the risks involved with developing, purchasing and managing health information systems (Kahn *et al.*, 2014; Zhang *et al.*, 2007). The use of such standards is based on the idea of developing agreed specifications or standards to facilitate the interoperability between the systems (Hammond, 2005). These will not depend on any proprietary systems but must be universally understood and accepted for data exchange (Thomas *et al.*, 2008; Lin *et al.*, 2006). Interoperability means that the communication language must be understandable by the systems at the receiving end of a communication (Hammond, 2005). The creation of interoperable standards depends upon two important concepts, syntax and semantics (Kim, 2009). Syntax interoperability refers to the structure of the message content, which is the equivalent of the rules for spelling and grammar. These must be agreed and standardised in both the sending and receiving sites. In contrast, semantic interoperability conveys the meaning of the sent message, the equivalent of a dictionary and thesaurus. However, without semantic interoperability, data can be exchanged but there is no assurance that it can be processed in a meaningful way at its destination (Kim, 2009).

Various standards development organisations have established different types of health data standards, each serving a particular purpose. From an institutional perspective, four types of standard may be distinguished (Hammond, 2005). Official standards are developed in an obligatory way because of government regulations (e.g. by-laws). Voluntary standards are developed based on requests from interested industrial parties, but are not made mandatory by governments. For example, the HL7 and the European Committee for Standardisation (CEN) have the objective to develop voluntary technical standards. Industry standards are proprietary standards developed by one single company or group of companies. Open standards are characterised by the fact that everyone can participate in the development process without being a member of a specific group or institution.

Different types of health data standards have been suggested in the literature. For example, Park and Hardiker (2009) stated that current attempts to standardise the capture, representation and communication of medical data in such a way as to represent their meaning, rely upon three layers of artefacts. These are generic reference models for representing medical data (e.g. HL7 CDA and the EHR reference information model), agreed definitions regarding the structure of clinical data (e.g. openEHR archetypes and HL7 templates) and clinical terminology systems (e.g. LOINC and SNOMED-CT).

Kim (2009) suggested six types of health data standards including messaging, terminology, document, conceptual, application and architecture standards. Messaging standards specify the message format, data elements and structure to allow transactions to flow consistently between different systems (e.g. HL7 2.x versions and DICOM). Terminology standards provide specific codes and terms for clinical concepts such as diagnosis and diseases (e.g. ICD and SNOMED). Document standards specify the types of information that are included in a clinical note and how it can be located (e.g. CCR and CDA). Conceptual standards allow information to be transported through the systems without losing meaning and/or context (e.g. EHR). Application standards determine the way medical procedures are processed and how systems interact (e.g. CCOW). Architecture standards define how medical data are stored and distributed (e.g. PHIN).

3. Healthcare systems in Saudi Arabia

The delivery and management of health services to communities and regions in Saudi Arabia is a truly complex task. Saudi Arabia spans a large geographical area with fragmented healthcare systems whose quality of care varies considerably between its diverse and scattered regions. The Ministry of Health (MoH) is the main government agency entrusted with the provision of preventive, curative and rehabilitative medical services. Its functions include strategic planning, formulating specific health policies, supervising all health service delivery programs and monitoring and controlling all other health-related activities.

However, health services' inception in Saudi Arabia took place 60 years ago, more specifically in 1950, when the first campaign against malaria was launched. Following this, the healthcare system in the Kingdom grew steadily until 1980 when there was a period of rapid of expansion in every sector in Saudi Arabia due to the increase in economic wealth (Al-Yousuf *et al.*, 2002). In the early 1980s, the concept of primary healthcare became popular and the structure of the health sector started to become clear. Currently, the MoH runs a three-tier healthcare system which includes primary, secondary and tertiary levels; these correspond to health centres, general hospitals and specialist hospitals, respectively. Under the umbrella of the MoH, there are 20 health regions and the programs, plans and policies of the MoH are executed through this hierarchy (Al-Yousuf *et al.*, 2002).

In addition to the MoH, there are two other healthcare providers: the private health sector and other governmental public healthcare bodies (e.g. army force hospitals, national guard hospitals and university hospitals). While the MoH provides 58 per cent of healthcare services, the remaining portion is shared between other governmental bodies (23 per cent) and the private sector (19 per cent) (Altuwaijri, 2008). The total number of hospitals in Saudi Arabia is 387. The total number of beds in all hospitals is 53,519, with the number of beds in the MoH hospitals being 31,420, corresponding to 58.7 per cent of the total number of beds in the Kingdom. There are 2.2 beds per 1,000 persons, equating to one bed for 453 people. The total number of physicians in the Kingdom, including dentists, is 47,919; 21.6 per cent of these are Saudi. The number of dentists totals 6,049 (excluding those working in the private clinics) and 21.1 per cent of these (i.e. 1,275 dentists) are Saudi. The total number of pharmacists is 15,043 (excluding those working in the private sector); 1,875 pharmacists (12.5 per cent) are Saudi while 99 per cent of the pharmacists working in private pharmacies are non-Saudi. The total number of nurses is 93,735, 28.8 per cent of whom are Saudi (Ministry of Health, 2009).

4. Research methods

An exploratory interpretive approach was conducted to investigate the adoption decision of health data standards in the main tertiary healthcare organisations in Saudi Arabia. An interpretive paradigm allowed the researchers to better get insight and understanding the issues related to the adoption decision of an innovation at organisational level (Irani *et al.*, 1999). The authors considered a qualitative approach to be more appropriate in the context of this study as it is naturally associated with the epistemological assumptions of the interpretive paradigm and can be used to examine in depth a complex phenomenon in its natural setting (Cornford and Smithson, 2006; Yin, 2003).

A multiple-case study methodology was selected to carry out this research. Six main healthcare organisations in Saudi Arabia were chosen; these include the National Guard Health Affairs (NGHA), King Faisal Specialist Hospital and Research Centre (KFSH&RC), King Fahd Medical City (KFMC), the Security Forces' Hospital (SFH), Riyadh Armed Forces' Hospital (RAFH) and Riyadh University Hospitals (RUHs). These organisations are affiliated with several different tertiary hospitals located in different major regions and cities in Saudi Arabia such as Riyadh, Jeddah and Dammam. The six healthcare organisations were chosen because:

(1) they are considered among other ones in Saudi Arabia as the more advanced in terms of the quality of patient care, the IT infrastructures and medical education, and so the government is keen to maintain the positions of these organisations in accordance with international key performance indicators;

(2) their hospitals and facilities are recognised as the main referral tertiary centres to provide sophisticated treatments to the citizens in Saudi Arabia;

(3) they have the most highly qualified professionals in Saudi Arabia because of the availability of the required budget; and

(4) they are considered to be the main stakeholders involved in the project run by the Saudi Council of Health Services concerning the exchange of health information, and so such health data standards were expected to be adopted in these organisations which in turn give the authors the opportunity to investigate the key factors influencing their adoption decision.

4.1 Participants

The focus of this study was on the decision-making stage of the adoption of health data standards. The authors intended to focus on the target stakeholders whilst interviewing whoever was available as long as the person is somehow in charge in the adoption and selection of health data standards in the cases organisations. So, the purposive sampling method was used to identify the participants. IT departments were the started point since they are the main stakeholders responsible for the adoption process of the standards in the subject organisations. The mangers of the IT departments where conducted initially to identify all those people who were in charge in terms of the decision-making stage of the adoption process of health data standards and to provide the authors with a list of the current health data standards adopted by their organisations. In addition, the chain referral or snowball sampling method was also used to identify other informants. A snowball sample was obtained by asking participants to suggest someone else who was appropriate for the study. Through the snowball sampling process, some informants were neglected based on the researcher's knowledge and judgment as they were found to be not appropriate for this study. The number of participants totalled 33 persons, eight of these are from NGHA, seven are from KFSH&RC, four are from KFMC, four are from SFH, four are from RAFH and six are from RUHs. The participants were managers or senior officials constituting a mixture of different disciplines such as IT, data centres, health information management and informatics, medical records, systems integration and interfaces and lab and radiology departments. For reasons of confidentiality and to respect the promise of anonymity, the authors cannot reveal the identity of the participants throughout the paper; instead, they are referred to here as, for instance, participant, informant or interviewee.

4.2 Data collection

The data collection stage ran from January to July 2010. Semi-structured interviews and documents analysis were used to collect the empirical data. The 33 participants were conducted in person face-to-face to ensure that an appropriate expert had the opportunity to participate in the study, give feedback and tell his/her unique story relating to the adoption process of health data standards in his/her organisation. The semi-structured interviews lasted approximately one hour. The open-ended, semi-structured interview enabled the authors to ask probing and follow-up questions which allowed more in depth understanding of the phenomenon under investigation. The interviews were recorded using a digital Dictaphone. The IT departments of the cases organisations also provided the authors with some valuable documents relating to the IT and information infrastructures and integration issues and different documents with regard to the policies, strategic plans and general information about their organisations. The purposes of the documentation is to explain the organisational structure and to provide such details regarding the IT and information infrastructures and the integration methodology undertaken between the affiliated hospitals which can support setting the context for interviews or discussions within the organisation being studied.

The objective of the primary data are to collect information about the different factors of technological, organisational and environmental context influencing the adoption decision of health data standards in tertiary healthcare organisations in Saudi Arabia to develop a comprehensive TOE list of themes. As described previously, the technological context is essentially described by depicting the important attributes of the technology. The organisational context is depicted by descriptive measures concerning the organisation (e.g. scope, size and managerial structure) and is influenced by formal and informal intra-organisational mechanisms for communication

and control. The resources and innovativeness of the organisation also play a role. The environmental context refers to the different attributes of the external world in which an organisation operates. Since, however, there is no adequate adoption model of technology innovation at organisational level has been emerged yet to fit all the adoption scenarios as each case involves varied controls on the constraints and mechanisms to carry out the different activities required in the adoption process (Thomas *et al.*, 2008), the authors therefore focused on:

(1) To examine to what extent the applicability of Roger's (1995) Model and the economic perspective of standards, namely, network externalities and switching costs, within the circumstances of the adoption of health data standards in the tertiary healthcare organisations in Saudi Arabia;

(2) To explore other new insights factors based on the healthcare organisations in Saudi Arabia, and based on that several questions were formulated to lead the interviews, as shown in the questions used and asked during the interviews with participants:

- Have you carried out any pilots, evaluation or viewed any demonstrations regarding health data standards?
- How does the actual state of affairs regarding health data standards market impact on the adoption of standards?
- What are the main costs associated with the adoption of health data standards?
- What impact does prior knowledge of the costs have on the adoption of health data standards?
- How does the current information technology infrastructure impact on the adoption of standards?
- What are the organisation's motivations for adopting health data standards?
- How are the selected health data standards being supported in the organisation?
- What was the impact of the adoption on the adoption of health data standards on organisation?
- Have any activities been carried out by the government to support the uptake of health data standards?
- Have any activities been carried out by the government to promote medical data exchange in healthcare sector?
- What are the main challenges facing the adoption of health data standards in Saudi Arabia?

(3) To categorise the collected empirical factors based on the TOE framework. This was done through brainstorming sessions and coordinating with five key participants who agreed among others in the data collection journey to participate in the reviewing process as this would increase the reliability and validity of the findings. The authors first sent a summary of the findings to those key participants and once they agreed upon the listed factors, the suggested TOE list which contains all the critical factors was also sent to be reviewed and then revised.

4.3 Data analysis

The data analysis stage was approached through the guideline suggested by Braun and Clarke (2006) for thematic analysis. The guideline, as shown in Table I, involves six steps which are required for analysing qualitative data. The authors followed the six steps strictly in order to promote the validity and reliability of the results. In doing so, the authors first immersed themselves in the collected data. This was done through the transcription process of the tape-recorded materials and then reading and re-reading the data. Second, the researchers started to generate all possible and initial codes using computer assisted qualitative data analysis software, namely, QSR NVivo 8. In the third step, the researchers re-focused the analysis at a broader level. This required sorting and collating all the different relevant codes into potential themes.

Fourth, the themes were refined once again through two levels. At the first level, the researchers needed to read all the collated codes for each theme and then examine whether they appeared to form a coherent pattern. At the second level, the reviewing was undertaken at the level of the themes where the validity of each theme was examined in relation to the data set and thereafter whether the thematic map reflected the meanings evident in the data set as a whole.

Fifth, the researchers redefined and named the themes. This required going back to the theme codes and organising them into a coherent and internally consistent account with an accompanying narrative. Each individual theme had its own story that fitted into the broader overall story that the research was considering in relation to the research aim. Sixth, the researchers produced the final report telling the complex story of the findings supported by sufficient evidence of the themes within the data (i.e. code extracts) to demonstrate the prevalence of the themes.

5. Results

The results from the data analysis revealed that only few health data standards types including terminology (e.g. ICD, CPT and SNOMED) and messaging (HL7 v2.x and DICOM v3.0) standards have been adopted in the tertiary healthcare organisations in

Table I.
The six-step guideline for analysing qualitative data using thematic analysis approach developed by Braun and Clarke (2006)

Activities	Description
Familiarising yourself with your data	Transcribing data Reading and re-reading the data Noting down initial ideas
Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set Collating data relevant to each code
Searching for themes	Collating codes into potential themes Gathering all data relevant to each potential theme
Reviewing themes	Checking if the themes work in relation to the coded extracts and the entire data set Generating a thematic map of the analysis
Defining and naming themes	On-going analysis to refine the specifics of each theme and the overall story the analysis tells Generating clear definitions and names for each theme
Producing the report	Selection of vivid, compelling extracts or examples Final analysis of selected extracts Relating back the analysis to the research questions and the literature Producing a scholarly report of the analysis

Saudi Arabia. Table II describes briefly these standards and their versions in accordance to their healthcare organisations and the purposes of their adoption. Every case organisation in Saudi Arabia is at a different stage in terms of adopting these standards. The adopted standards are often based on the organisation's needs and expectations in terms of managerial (e.g. analytical, accreditation and benchmarking), technical (e.g. interoperability and integration), educational (e.g. clinical research) and governmental (e.g. terminology such as ICD and SNOMED standards helps MoH in producing medical statistics concerning the health situation in Saudi Arabia in general) purposes. The terminology standards are in limited use and most of the data were built on a proprietary format. Exchanging medical data semantically among the tertiary hospitals or other healthcare providers in Saudi Arabia would be impossible. In addition, obtaining meaningful insights into the medical information, through the provision of accurate statistics and reports, was also limited as a result of the inadequacy of the data. Therefore, producing medical statistics and reports, such as mortality data, concerning the health situation in Saudi Arabia in general was a real concern. Table III shows a summary description of the TOE-related factors influencing the adoption decision of health data standards in the tertiary healthcare organisations in Saudi Arabia. The following illustrates these factors impacting the adoption decision of health data standards in the case organisations. These factors were identified by the authors through analysing the empirical data and then classified based on TOE taxonomy.

5.1 Technological-related factors

5.1.1 Complexity. Although adopting health data standards is a very complex task in many countries, the situation in Saudi Arabia, as pointed out by many participants, is much more difficult. This is because Saudi Arabia is a newcomer to the area of advanced health information systems and is therefore deficient in many areas that are necessary to understand or cope with the standards. According to the participants, most of the leading healthcare providers in Saudi Arabia rely on consultants in the adoption of health data

	Healthcare organisations						
	NGHA	KFSH&RC	KFMC	SFH	RAFH	RUHs	Purposes
Health data standards versions adopted by the case organisations							
ICD	10 AM	10 AM	10 AM	9 CM	9 CM	9 CM	Statistics Reports Benchmarking Research
SNOMED	CT	CT	No	II	II	II	To register and report the cancer cases annually to the Saudi Oncology Centre
CPT	No	Customised	No	No	No	No	Measuring productivity Providing statistics Benchmarking Research Billing
HL7	v2.3	v2.3	v2.3	v2.2	v2.2	v2.2	To facilitate the integration of different health information systems into the backbone system
DICOM	3.0	3.0	3.0	3.0	3.0	3.0	To facilitate the integration of different image systems into the PACS

Table II. Health data standards and their versions adopted in the case studied organisations and their purposes

TOE	Factors	Description
Technological	1. Complexity	The cases are newcomers to the area of health data standards and at recent time cannot understand or cope with the standards
	2. Compatibility	Two main compatibility issues within the case infrastructures including technical and culture challenges
	3. Switching cost	The high degree of switching cost is due to the unfamiliarity of the cases with the existing resources, skills and the infrastructures
	4. Market uncertainties	There appears to be confusion of interoperability within the national market owing to the lack of a national regulator
	5. System's integration	The cases need the standards to facilitate the integration of the systems distributed among different remote locations and sites
	6. Enhancing the use of advanced systems	The cases are hesitant about adopting or increasing the utilisation of advanced clinical information systems because these systems require a robust standardised information infrastructure
Organisational	1. Organisational characteristics	The cases are most in need of adhering to health data standards in order to manage the size and complexity and to support medical researches and education. In term of organisational structure, numerous faults occur in drafting and proposing the specifications and requirements of the new systems owing to the political and bureaucratic issues
	2. Lack of adequate policies and procedures	The hospital policies and procedures are a set of guidelines that should be defined precisely and should be followed rigorously with every new system
	3. Resistance to change	A dedicated change management programme must be established because clinicians in Saudi Arabia lack a background in health data standards and are often unaware of the benefits that standards can bring to the organisation
	4. Lack of information management plan	The case lack the required plan for managing the medical data, and this might explain why the cases have just implemented few standards since they still do not have a clear vision and mission in this regard
	5. Data analysis	The cases are tertiary healthcare providers required to produce statistical reports on a regular basis excluding any human bias, which in turn is required high quality and structured medical data infrastructure
	6. Accreditation	One of the main initiatives taken by the cases is the acquisition of certain accreditation from leading international medical commissions. The hospitals must follow certain standards, including some health data standards, in order to be accredited
Environmental	1. Network externalities	The case organisations are always confined by market standards for reasons such as retaining market compatibility and support, benchmarking and producing certain reports required by the government

Table III.
Summary of the key TOE-related factors influencing the adoption decision of health data standards in the case organisation

(*continued*)

TOE	Factors	Description
	2. National healthcare system	The national healthcare system is seen to be insufficiently organised to allow data exchange amongst healthcare providers and this might be one of the reasons that the adoption of health data standards remains frustratingly low where it does exist
	3. Shortage of professionals	The shortage of professionals in the area of health data standards is the biggest barrier in Saudi Arabia and across the region
	4. Lack of a national plan for medical data exchange	A national plan for medical data exchange is needed to set and define the national standards, policies and specifications which will be required to enable the exchange of medical data across the health sector and to establish the national health information network
	5. Lack of a national regulator	A national regulator is needed to lead and promote the development of standards and the related activities in the country

Table III.

standards. One participant stated: "We are thinking to bring a consultant from Harvard to do the coding structure. Getting experts from outside will be more meaningful as they will be coming here and looking at how the hospital is functioning and what the value is of the coding structure that we are going to obtain".

5.1.2 Compatibility. Compatibility was indicated by different participants as a negative factor to the adoption of health data standards. The case organisations with legacy IT infrastructure were found to face difficulties when they tried to adopt the new versions of HL7 and to update the ICD-9 clinical modification (CM) with the ICD-10 Australian modification (AM), as one informant explained: "the application of ICD-10 AM does not meet the hospital's expectations since what we look for is to have it integrated into the hospital's backbone system with the code finder system to enable physicians to assign automatically the proper codes for the treated cases". Many cases reported by the participants showed that the existing infrastructure has a negative impact on the adoption of health data standards. For example, KFSH&RC failed to adopt HL7 CCOW since it necessitated some non-existent requirements and infrastructures in order to function properly. The compatibility of the new standards with the organisational work environment, in terms of factors such as experiences, culture, practices, values and skills, was also indicated as issues, for example, one participant stated: "I think the decision to convert to ICD-10 AM was inaccurate because one of the greatest benefits introduced by ICD is benchmarking and therefore we always compare ourselves to North American or UK countries; also, most of the literature that we read in order to compare ourselves is based on journals in those countries".

5.1.3 Switching cost. The cost was seen as a negative factor to the adoption decision of health data standards in the case organisation. The cost is due to the unfamiliarity of the case organisations with the existing resources and skills regarding the standards. For example, there is a lack of experts who can deal with or lead the adoption of the standards. As a result, a great deal of staff training and a high degree of change management will be required. The mapping issues from the old information infrastructure to the new standardised one will be also a real cost concern as one informant said: "We were disappointed when the government chose ICD-10 AM.

Now, we are suffering with the mapping process which I think is going to cost a lot of money".

5.1.4 Market uncertainties. The participants advocated that the healthcare organisations' policies and procedures should be redefined to only support the best of breed systems in order to reduce the risk of interoperability barriers. The reason for this is that every vendor customises the standards based on a proprietary format of requirements to gain competitive advantages in the market. By dealing only with leading vendors, the hospitals will ensure that the extent of customisation is reasonable and has also been proven in the industry not to be in conflict with other standards and/or specifications. One participant said: "What I have noticed regarding communication standards such as HL7 and DICOM is that, although the companies say their systems are standard compliant, when it comes to the real situation, there is an issue of regarding integration". There also appears to be confusion within the medical information systems market today in Saudi Arabia owing to the lack of a national regulator in this area, as one participant stated: "The national vendors always advocate that their systems are standard compliant but this is not the truth. We need a national body to certify them".

5.1.5 Systems' integration. The majority of the participants agreed that one of the main reasons for adopting health data standards is to facilitate integration among the different systems. The case study organisations were running a variety of systems distributed among different remote locations and sites. These systems cannot be integrated through a point-to-point interface solution as this turned out to be an endless process, requiring a high degree of interface engineering and support. One interviewee said: "The ultimate goal is to make the messages across the systems uniform and, even more complicated, across the regions and hospitals, through the HL7 integration engine which will provide us with total ownership solutions and easy integration between the solutions".

5.1.6 Enhancing the use of advanced systems. The empirical findings showed that the case organisations are hesitant about adopting certain advanced health information systems. This is because such systems require a robust standardised information infrastructure in order to be implemented successfully. The interviewees also described other advanced systems (e.g. data warehouses and CPOE) that are currently being used in the hospitals in a less than effective way because of the nature of the proprietary format of the data structure in the hospitals, as one participant said: "Due to the lack of standards, there are some difficulties in terms of digging for information because we cannot extract the information from free text or images. This prevents us from obtaining fruitful data through the data warehouse; the need for information from the data warehouse will push management to work hard on the health data standards in order to have a date warehouse that will replicate fruitful data".

5.2 Organisational-related factors

5.2.1 Organisational characteristics. This refers to descriptive measures regarding the healthcare organisation. The authors found three main aspects within this factor influencing the adoption decision of health data standards included organisation size, structure and culture. While the managerial structure of the case organisations has a negative impact, the remaining aspects were seen to have a positive impact on the adoption decision of health data standards. For example, all the cases in this study were multi-site tertiary healthcare organisations with hundreds of thousands of registered patients. The participants explained that, although the standards are

required in every healthcare provider, the tertiary hospitals are most in need of adopting such standards. The tertiary hospitals run complex systems which require, among other things, a high level of interoperable IT infrastructures in order to operate efficiently and effectively. For example, the lifecycle of just one case in a tertiary hospital may sometimes require sophisticated treatments involving numerous physicians and medical staff. The medical language must be consistent and the data must be synchronised between the different groups of physicians; such information must also be available and accessible at any point in the care.

The data also revealed that tertiary Saudi healthcare organisations are multi-cultural environments with approximately 65 nationalities working as medical staff in those hospitals. This means that a great number of costly training programmes are required because of the high turnover rate and the considerable demands placed on new medical personnel. One informant said: "One thing is that we have employees from more than 65 countries. There is a high turnover rate of employees in the hospitals since the average stay of nurses in the hospital is about one to one-and-a-half years, for example, we hire 100 new nurses weekly. The orientation of the medical staff is one of the most serious challenges in Saudi Arabia because we do not have the same level of knowledge and we thought following certain standards might be one of the solutions".

In relation to the organisation structure, it appears that the case organisations lack an adequate organisational structure, in particular with regard to decision making in the adoption of health information systems. Numerous faults occurred in drafting and proposing the specifications and requirements of the new systems owing to the political and bureaucratic issues. A poor organisational structure results also in a conflict of orders between the related departments during the adoption processes.

5.2.2 Lack of adequate policies and procedures. The empirical evidence exposed that there is a lack of sufficiently well documented and detailed policies and procedures regarding the adoption of new health information systems in the case organisations. One participant explained: "We lack documentation or 'lessons learned' databases which will enable parties to review the experiences of others, thus lessening the problems. Every time there is a problem, a dedicated committee is established to resolve the problem since no clear policy or procedure exists in the hospital". The lack of adequate policies and procedures results in less quality system with many messing of essential features and standards. In addition, healthcare organisations in Saudi Arabia still lack adequate policies and procedures that would offer some sort of incentive (and/or inflict certain punitive measures) to ensure the application of health data standards in hospitals on a daily basis, as one participant reported: "I do not think that the doctors in the public healthcare sector will enter the ICD codes by themselves, especially the older ones, since there is nothing to force them to do so".

5.2.3 Resistance to change. The participants indicated that there is less interaction amongst clinicians at the level of adhering to the standards in tasks on a daily basis, as one interviewee explained: "The standards are meeting with some resistance from the physicians because they do not realise the importance and benefits of the terminology coding; they think that it is just extra work. It is the role of high-level management in the medical services to force the physicians to adopt and use terminology coding". Similar view by another participant when said: "People's reactions are a barrier to the adoption of health data standards because they lack an understanding of the benefits

brought by standards. Therefore, we should use some educational programs to train and make people in the medical field aware of the value of the information and its role in improving healthcare".

5.2.4 Lack of an information management plan. The case study organisations still lack an information management plan at the level of how data are, for example, predefined, characterised, structured, stored, exchanged, integrated, accessed and governed. This is due to several reasons, such as a lack of experts in the area of health informatics and the absence of a national plan and a government role within the management of medical information. For example, the privacy and confidentiality of patients' information was a real concern since there is no specific health privacy legislation governing hospitals in Saudi Arabia. Different documents have emphasised this issue, as a one medical information strategic plan stated on: "With the absence of specific health privacy legislation governing hospitals in Saudi Arabia, the hospital has pursued a self-regulatory approach and has modelled its policies on internationally recognised privacy principles for the protection of personal information of both Saudi and non-Saudi nationals".

5.2.5 Data analysis. The findings showed that the analysis of data are an important factor for the case organisations in order to help the top management to acquire meaningful insights from the data by carrying out accurate statistical analysis, excluding any human bias. Data analysis is a decision-supporting system and its success or failure depends on the quality of the data that are inputted; it also relies on how well the systems are integrated and how well the data are structured and predefined. One participant stated: "We wanted to make sure that every medical service introduced by the hospital was properly coded and so we developed our own CPT version with an American group to be able to benchmark with others and produce accurate reports and statistics".

5.2.6 Accreditation. Gaining accreditation is one of the main initiatives undertaken by the top management in the case organisations. There are different means by which hospitals can be accredited, for example, the hospital might be internationally recognised as a highly standardised hospital and thereafter the value of the hospital will also increase. This then reflects on the reputation of the top management. Since the MoH is still lacking a national agent to oversee the accreditations in Saudi Arabia, every hospital works closely with international consultants to be accredited. This might result in a wide divide between the hospitals in terms of different levels and stages of health data standards adoption.

5.3 Environmental-related factors

5.3.1 Network externalities. The network externalities have a positive pressure on the case organisations to adopt health data standards. The majority of the participants agreed that HL7 and DICOM have been imposed because they are the current market standards for communication between different health information systems and so hospitals cannot choose other standards if they want to retain market compatibility and support. The terminology standards such as ICD and SNOMED had been adopted because they are international ones used throughout the world. They are being used by the case organisations to report annually certain medical information to some government bodies (e.g. the MoH and the Saudi Oncology Centre) in order for them to produce medical statistics and reports concerning the health situation in Saudi Arabia in general, and thereafter benchmark against international statistics and reports.

5.3.2 National healthcare system. The empirical evidence exposed that the national healthcare system in Saudi Arabia is not sufficiently well organised to allow data exchange amongst healthcare providers. There are substantial variations in the management and provision of medical services in Saudi Arabia. Every healthcare provider has its own policy and procedures that usually depend on the hospital's qualifications and needs, as one participant said: "I think the healthcare system in Saudi Arabia is not organised enough to support data exchange; for example, every healthcare provider has its own policy regarding, for example patient eligibility and treatment and there are always exceptions". The reason for this is that a clear national policy is still lacking with regard to how medical services are, for example, managed, operated, structured and provided to patients.

5.3.3 Shortage of professionals. The participants agreed that the shortage of national professionals is one of the main factors which is hindering the development and adoption of health data standards in Saudi Arabia and across the region. Saudi Arabia is newcomer in the area of advanced medical technology practices and solutions such as health data standards and therefore the current education and training cannot meet the need, as one participant reported: "Most of the ICD coders are expatriates and you will be surprised because the Saudi coders might be less than 5% of the total number of coders in Saudi Arabia".

5.3.4 Lack of a national plan for medical data exchange. Due to the lack of a national plan for medical data exchange between healthcare providers in Saudi Arabia, the case organisations prefer to invest in their IT infrastructure, in areas such as networks, platforms and other advanced clinical information systems, rather than focusing on health data standards from which they cannot benefit directly. One participant said: "If the adoption of the standards is very expensive and has to be allocated a high proportion of the annual IT budget, then why do we need to adopt health data standards while we are not exchanging data with others?" another informant said: "There is no progress in the development of health data standards in Saudi Arabia or in the region because there is no data exchange between the related healthcare organisations except within the organisation itself".

5.3.5 Lack of a national regulator. Although several government entities and commissions have spoken about the standards, no one has taken the lead to develop and promote such standards in Saudi Arabia, as one participant explained: "One of the negative factors regarding health data standards is the absence of a national regulator. Who is responsible for the ICD-10 AM? It is not the MoH, not the Saudi Commission of Health Services and not the Saudi Commission of Health Insurance". Another participant said: "We do not have a group for clinical information technology in Saudi Arabia and there is, for example, no HIMSS or HIPAA representative group in the country or there is no national reference in this regard".

6. Discussion

In total, 17 factors were identified through the empirical data impacting the adoption decision of health data standards in the case tertiary healthcare organisations in Saudi Arabia. The results showed the applicability of the Rogers's (1995) model through two main antecedents including complexity and compatibility. The participants also explained various operational, managerial, strategic, technical and organisational benefits to the adoption of health data standards, but according to the five key reviewers of the TOE list, these are most likely related to the systems' integration,

enhancing the use of advanced medical systems, data analysis, acquiring the required accreditations and supporting medical research and education. The five key participants assumed that these are the main benefits within the case organisations and so the relative advantages factor seems to be more generic and wide one and should be overlooked. The data also showed the ineffectiveness of the trialability and observability in Rogers's model. As described by the participants, health data standards are a very complex subject in nearly every country and the situation in Saudi Arabia is much more difficult.

The concepts of such important fields (e.g. health informatics and biomedical engineering) are still in their infancy in Saudi Arabia owing to that just a few universities in the Kingdom of Saudi Arabia have recently begun to offer some new courses in those fields. The immaturity of health data standards and the market uncertainties also makes the circumstances more difficult for developing nations such as Saudi Arabia to understand and deal with the process of standardisation for health data in limited basis without national plans and strategies. The participants explained that standardisation for health data requires champions, change management and national initiatives to take the lead in the development process. The key participants explained that every country should launch two different initiatives in order to promote the adoption of health data standards in healthcare organisations. First, there is a need for a national regulator in order to lead and promote the development of standardisation for health data and the related activities in the country. Second, a national plan for medical data exchange should be established to set and define the standards, policies and information specifications which will be required to enable the exchange of medical data across the health sector and to establish the national health information network.

The two essential theories of the economic perspective of standards, namely, network externalities and switching costs, had a direct impact on the adoption of health data standards in the case organisations as pointed out by the five key participants. The findings showed the positive impacts of the network externalities on the adoption of health data standards in order for the case organisations to retain market compatibility and support and also important to benchmark against other national or international hospitals. The findings showed the negative impact of the different switching costs associated with the adoption of the standards in the case organisations, these include, for example, staff training, change management, mapping the old information to the new standardised infrastructure and the legacy systems. During also the revision of the TOE list, the five key participants suggested some changes to the list. For example, the general support required throughout the adoption process of health data standards at the organisational level should be part of the organisations' policies and procedures. The participants illustrated that many different organisational activities, resource allocation and various forms of support must be launched during the adoption of every new innovation in healthcare organisations. These varies depends on the innovation itself, and therefore, if there are no adequate policies and procedures with regard to the adoption process, organisational support will always be a barrier to the adoption process since it will be difficult to determine the different forms of support required in advance. So, achieving the missing support will depend on social aspects such as organisational culture, personal attitudes, organisational structure and staff relationships and trust.

Another suggestion is that the shortage of professionals with regard to standardisation for health data are the biggest barrier in Saudi Arabia and across

the region. Since this barrier is not specific to certain organisations in Saudi Arabia but is across the board, the participants thought it is best to place this factor under environmental rather than organisational factors. Another issue pointed by the key participants is that a dedicated change management programme should be established at both the organisational and national level owing to the resistance amongst clinicians in adhering to the required standards on a daily basis and the substantial variations in the management and provision of medical services between the different entities constituting the national healthcare system. The clinicians in Saudi Arabia lack a background of the importance of the medical data to the quality and equity of medical services and are often unaware of the benefits that standards can bring to the organisation. In addition, the privacy and confidentiality of patients' information was a real concern since there is no specific health privacy legislation governing hospitals in Saudi Arabia. An important issue is also the lack of a clear national policy with regard to how medical services are, for example, managed, operated, structured and provided to patients, and so, a clear and appropriate change management strategic for integrating the fragmented systems is seen to be an important issue. Nevertheless, the following discusses the complete factors in relation to the literature and in accordance to the TOE taxonomy.

6.1 Technology-related factors

The authors identified six factors within this group influencing the adoption decision of health data standards in the case tertiary healthcare organisations in Saudi Arabia. The complexity and compatibility can be subsumed the innovation attributes of Rogers' (1995) paradigm. The complexity and compatibility were also validated in the prior related studies. For example, Lin *et al.* (2010) found that the complexity and incompatibility of HL7 2.x versions with the existing IT infrastructures in Taiwanese hospitals resulted in a low rate adoption. Egyedi and Loeffen (2002) explained that IT-related standards are often a problem, therefore, the advantages of any improvements in and between the versions must be weighed against those issues related to their compatibility or otherwise. Thomas *et al.* (2008) asserted that the successive versions of IT-related standards often cause compatibility problems and challenges for the implementers. Khoumbati *et al.* (2006) indicated that compatibility can be also related to the prior experience of the medical staff, and therefore, the accumulative experiences of the organisations' staff can be seen as an antecedent to the adoption of innovation (Fichman, 2004).

The switching cost and market uncertainties can be illustrated through the stream of economics perspective of the standards. For example, the new standard might create a high degree of drag, because of unfamiliarity in terms of the existing resources and skills in an organisation with the new standard. The high sunk cost is because organisations have invested in their current infrastructure and so will be very reluctant to discard an amount of capital and equipment as a result of the requirements of adopting the new standard (Thomas *et al.*, 2008; Hovav *et al.*, 2004).

The results indicated that the case tertiary healthcare organisations in Saudi Arabia have been looking for health data standards as the way to facilitate the integration between different systems and thereafter to enhance the use of advanced health information systems. This conclusion is in line with prior studies. For example, Lin *et al.* (2010) stated that the purpose of health data standards is to reduce the complexity of interface design and to facilitate information exchange among various applications. Health data standards can also reduce the expensive custom-made interfaces required

in making changes to any of the systems involved and therefore facilitating the integration between different systems (Spooner and Classen, 2009; Jenders, 2007; Luic and Striber-Devaja, 2006; Hammond, 2005). Luic and Striber-Devaja (2006) considered health data standards as the main component in enabling integration between a large number of primary and secondary healthcare organisations and referred service organisations and afterwards towards the development of patient-centric EHR system and national health information networks and to enhance clinical-decision support systems performance (Spooner and Classen, 2009; Jenders, 2007; Hammond, 2005).

6.2 Organisational-related factors

Six factors, namely, organisation characteristics (e.g. size, structure and culture), the lack of adequate policies and procedures and medical information management plan, resistance to change, data analysis and accreditation, were identified within the organizational-related factors to influence the adoption decision of health data standards in Saudi tertiary healthcare organisations. From the data analysis, it is evident that the tertiary large hospitals in Saudi Arabia tend to be more innovative towards health data standards than medium and small hospitals. The tertiary hospitals are most in need of adopting health data standards due to the greater complexity of the interventions within those hospitals and therefore a very well structured information infrastructure in those hospitals tend to receive more attention (Braa *et al.*, 2007). The large organisations are also made up of many agencies and industry partners; thus, effective exchange and the sharing of information are greatly enhanced by the use of standards (Thomas *et al.*, 2008; Chen, 2003). Healthcare organisations with more hospitals in their system are indeed more likely to exchange electronic information between those affiliated hospitals (Miller and Tucker, 2014). Valuable information are also needed to support medical universities and research centres in the biomedical and clinical fields with large numbers of patients and to provide access to longitudinal clinical information (Ohmann and Kuchinke, 2009; Spooner and Classen, 2009; Hammond, 2005).

However, the participants explained that the organisational structure in Saudi public healthcare organisations which is based on the centralised and formalised approach has a negative impact on the adoption of health data standards. The reason is that during the adoption process, this requires various changes to be made to the organisational structure, such as adjustments to reward schemes, changes in authority or responsibility patterns, or the shifting of power centres, these often meet with some resistance in the public organisations (Kamal, 2006; Davidson and Chismar, 1999).

The multi-cultural healthcare organisation seems to be a new factor derived from the case organisations. In related studies, the culture issues were discussed based on three aspects including the organisation itself (i.e. referring to the extent to which the organisation adopted innovation often, early and thoroughly) (Fichman, 2004), the attitude of top managers towards standards (Thong and Yap, 1995) and the opinions and beliefs of the organisation's staff towards standards (Thomas *et al.*, 2008). The reason is possibly that only those developing countries with a strong economic base, such as Saudi Arabia, have such large multi-cultural healthcare organisations. Due to a shortage of medical staff, the government in Saudi Arabia recruits thousands of medical personnel from different nations every year to work in the healthcare sector as a result of the solidity of the national economy. This means if the medical language is fully standardised worldwide, the synchronisation of the level of the knowledge between medical staff and training sessions in Saudi Arabia will be in less demands and so the cost of medical services will be decreased whilst the quality and safety will be improved.

Concerning the lack of adequate policies and procedures, the literature explained different activities and forms of support required during the innovation adoption in an organisation. These are such as top management support (Kim, 2009; Doebbeling *et al.*, 2006; Fichman, 2004; Bates *et al.*, 2003), the allocation of the required technical, human and financial resources (Zhang *et al.*, 2007; Hovav *et al.*, 2004) and training programmes and awareness campaigns (Kim, 2009; Paré and Trudel, 2007; Leonard, 2004). However, when clear policies and procedures are properly set and rigorously followed up, the organisation can ensure that every necessary form of activity and support are adequately and systematically provided and allocated based on the project's needs and its value to the organisation. However, the lack of medical information management plan found to be in line with some prior studies' conclusion. For example, Greenhalgh *et al.* (2010) noticed that the concern of clinicians, in terms of information governance controls, access to information and gaining patients' consent, was one barrier to the adoption of a shared electronic summary record in England. Zhang *et al.* (2007) found that legal and ethical concerns (privacy and security) were key barriers to the development of standardisation for health data in China. Security and protection of patient information are not only demanded by the patient himself, but in most developed countries they are also required by law (Ledikwe *et al.*, 2014; Haak *et al.*, 2003). Therefore, the development of a skills and tasks inventory would be a relatively low-resource first step in clarifying staffing needs for the generation and use of strategic information (Ledikwe *et al.*, 2014).

In the light of resistance to change, the literature has emphasised its importance (Rozenblum *et al.*, 2011; Greenhalgh *et al.*, 2010; Lin *et al.*, 2010; Fitzgerald *et al.*, 2008; Hammond, 2005; Stablein *et al.*, 2003; Lyons *et al.*, 2005). The adoption of health data standards involves many levels of interaction and management of both personnel and systems, representing major organisational change (Fitzgerald *et al.*, 2008; Doebbeling *et al.*, 2006). If hospital staff were more knowledgeable about standards, there would be fewer advocator obstacles and lesser user resistance against them (Luna *et al.*, 2014; Lin *et al.*, 2010). However, in many developing countries, clinicians are a considerable challenge for maintaining data quality within health information systems (Ledikwe *et al.*, 2014). The engagement of clinical expertise in the adoption decision of health data standards is also crucial because clinical experts create scenarios for the content of standards, giving them actors, roles and interactions through which the required data structures and data exchanges are predefined and derived (Hammond, 2005).

The positive impact of data analysis and accreditation factors on the adoption decision of health data standards is in line with some related studies. For example, the accreditation has one of the strongest relationships with interoperable infrastructures in healthcare organisations since it facilitates the documentation and generated performance measures with such respected agencies (Furukawa *et al.*, 2008; Johnson and Ventura, 2004). The interoperable infrastructures available to healthcare organisations also create a vast potential for quality improvement since they allow such organisations to measure their performance through the use of international standards and definitions, and thereafter benchmark their care against other healthcare systems (Klann *et al.*, 2014; Szydlowski and Smith, 2009; Sequist *et al.*, 2005). The efficient collected information would also enhance regional system coordination, thus diminishing duplication of efforts and financial burden (Olsen and Baisch, 2014).

6.3 Environmental-related factors

Within this group, five factors were identified to influence the adoption decision of health data standards in the tertiary healthcare organisations in Saudi Arabia.

The network externalities is one of the two main theories used within the stream of economics perspective of standards and is related to the benefits created through the adoption of the new standards by the potential community of adopters (Miller and Tucker, 2014; Hovav *et al.*, 2004). The participants explained that the adoption of health data standards are imposed because they are the current market standards, and therefore, the value of the standards is increased due to the reductions in the cost of the support (due to economies of scale) and the increase in potential synergies through the facilitation of interactions among adopters (Chaudhry *et al.*, 2006).

The national healthcare system appears to be a new factor derived from the empirical data. In the literature concerning developing countries and sustainable healthcare systems, this has been seen to be an important issue for the development of appropriate strategies for integrating the fragmented systems. Healthcare systems in developing countries vary immensely between regions and geographic areas (Luna *et al.*, 2014). This variation results in inequities and uneven development infrastructures which make the integration between the fragmented areas and systems more complicated (Smith *et al.*, 2008; Braa *et al.*, 2007; Jacucci *et al.*, 2006). Also one main variation is the lack of professionals to lead healthcare systems in urban regions (Luna *et al.*, 2014). For example, Lorence and Churchill (2005) found that non-uniformity between hospitals, with regard to the adoption of security standards, was resulted from a lack of local expertise. The shortage of professionals in Saudi Arabia is also confirmed by other studies concerning developing countries (Greenhalgh *et al.*, 2010; Lin *et al.*, 2010; Braa *et al.*, 2007; Zhang *et al.*, 2007; Jacucci *et al.*, 2006).

The negative impacts of the lack of a national plan for medical data exchange and national regulator on the adoption decision of health data standards are very much in consistence with prior studies. Miller and Tucker (2014) in their study explained that although compatibility or capability alone will be sufficient to allow sharing data externally between hospitals, the government should ensure comprehensive coverage of medical data exchange. For example, hospitals with large systems are less willing to share data with others for competitive advantages and data ownership reasons. Kruse *et al.* (2014) and Hovenga (2008) emphasised that there is a need for an agreed national plan of health data standards for every nation to maximise interoperability across the health sector and to decrease the risks associated with the implementation of non-standard applications.

To summarise, the findings exposed few health data standards, including only terminology and messaging standards, were adopted by the tertiary healthcare organisations in Saudi Arabia. Different issues related to the TOE framework were also reported by the tertiary healthcare organisations in Saudi Arabia impacting the adoption of health data standards. Table III summarises the TOE-related factors influencing the adoption decision of health data standards in the tertiary healthcare organisations in Saudi Arabia. In addition, the findings showed that every tertiary healthcare organisation in Saudi Arabia and based on individual efforts is at a different stage in terms of adopting these standards for reasons such as managerial, technical, educational and governmental concerns. However, the relevant literature explained that standardisation for health data are an authoritative field in which the mechanisms of the marketplace do not work (Zhang *et al.*, 2007; Halamka *et al.*, 2005). Health data standards developed for a particular market (e.g. the North American market) cannot, in general, be applied in other markets (e.g. the European market) without modification owing to the differences between countries regarding medical policies and procedures (Eichelberg *et al.*, 2005). According to Venkatraman *et al.* (2015), the organisational

arrangements of each healthcare facility vary from country to country due to the cultural, economic and funding condition. Braa *et al.* (2007) emphasised that a national strategy concerning integration across health domains, together with the development of a minimal set of data standards, are important in developing countries in order to at least reduce some of the challenges facing the delivery of medical services in those countries. In addition, the concept of trying to define in advance all the standards that will be required for medical data exchange is not the solution. Instead, adopting "just-in-time" standards and building in blocks, with the ability to produce effective and acceptable standards quickly, is the most appropriate solution for making progress towards achieving interoperability (Tenenbaum *et al.*, 2014; Hammond, 2005). Any interoperability gaps are likely to be difficult to identify before progress is made in the development of a national health information network (Hammond, 2005).

7. Conclusion

Although the level of adoption of health data standards remains frustratingly low, little is known about their adoption, and in particular the critical factors influencing their adoption in healthcare organisations. In addressing this gap in the literature, this study has investigated the adoption decision of health data standards in healthcare organisations in Saudi Arabia. The main six tertiary healthcare organisations in Saudi Arabia were participated in this study and different data collection methods were used included semi-structured interviews with 33 different decision makers at various levels and departments of the subject organisations, and documents analysis to identify critical factors to the adoption decision of health data standards. The results indicated that few health data standards were adopted by the case organisations. These include ICD-0 CM, ICD-10 AM, SNOMED, CPT, HL7 2.x versions and DICOM 3.0. The results showed that every case organisation is at a different stage in terms of adopting these standards. They are therefore often based on the organisation's needs and expectations in terms of managerial, technical, educational and governmental.

The results offer insights into some of the technological (e.g. complexity and compatibility of health data standards, switching costs, market uncertainties, systems integration and enhancing the use of advanced systems), organisational (e.g. the lack of adequate policies and procedures and information management plan, resistance to change, data analysis and accreditation) and environmental (e.g. the lack of national regulator and data exchange plan, national healthcare system and the shortage of professionals) influences on the adoption decision of health data standards in the tertiary healthcare in Saudi Arabia. The implication of this study makes a contribution at different levels. At the theory level, it demonstrates the application of different IT-related standards theories, Rogers' paradigm and the theories surrounding the Economics of Standards, into the area of health informatics. It also presents a comprehensive list of critical factors to the adoption of health data standards which allows others to relate their views to those reported herein. At the practice level, it enables the decision makers, and in particular those in developing nations, for more effective strategy of health data standards adoption. Such a key strategy of the adoption interventions is the existence of a national formal reference for health data standards to lead the development and the promoting of the standardisation for health data in the country. Part of this strategy is to examine the capabilities of the national healthcare providers in attempting to fill the gap between what we should have and what is really going on in order to facilitate data exchange between different medical entities. Another important issue is the need for change management plan to examine

technical implementation metrics, measures of acceptance and the use of health data standards by different medical groups. This plan requires significant engagement from the national medical groups and entities to clearly specify health privacy legislation since there is always a concern about the privacy and confidentiality of medical data.

However, some limitations of this study are worth noting. The results from the qualitative data were difficult to generalise to other populations. For example, the structure of the health sector varies from country to country as each health sector has its own characteristics that affect and are affected by national circumstances. In addition, health data standards and the issues of the adoption process in Saudi tertiary healthcare organisations were evaluated in term of the pre-adoption decision-making stage, and so the post-adoption implementation stage was out of the scope of this study. In doing so, some potential future directions for research in this field are recommended to provide a more grounded theory. For example, theory resulting from a qualitative study usually requires further examination by employing quantitative studies. In addition, further research is suggested to evaluate through qualitative and quantitative studies the implementation of the standards, and in particular the terminology standards, by their intended users, and to measure in to what extent the clinicians and the key stakeholders adhere to the health data standards in their daily routine tasks.

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