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Modelling the utilization of cloud health information systems in the Iraqi public healthcare sector

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ABSTRACT

The Iraqi healthcare sector has been suffering from health records management issues from the perspectives of low information technology integrity and data complexity. As a solution, cloud computing services can offer an alternative, low-cost, and reliable way to store, manage, and retrieve health-related data, as well as monitoring patients' health conditions anywhere and anytime using any device with any platform. The migration to cloud services is not yet widespread in Iraqi health facilities due to various challenges, including security and privacy, legal policies, and implementation. For instance, there has been no research shedding light on the utilization of cloud computing services in Iraqi hospitals' health information systems. This study proposed a model by defining the critical success factors influencing physicians' confirmation and behavioral control toward utilizing cloud health information systems in Iraqi hospitals. The model's variables were statistically investigated by utilizing an online questionnaire. Data were collected from a probability sample of 259 physicians working in four Iraqi high-IT hospitals. The collected ordinal data were analyzed using the PLS-SEM approach as a nonparametric second-generation multivariate analysis. The results showed that the effects of system compatibility, system complexity, security, and privacy on physicians' confirmation and behavioral control were statistically significant. Both confirmation and behavioral control had a positive effect on physicians' utilization of the technology in the Iraqi hospitals. It is believed that such finding may help to aid the current understanding of cloud health systems in managing health data as well as providing the necessary recommendations for policy makers to direct healthcare professionals to continuously consider the use of modern information and communications technology in the workplace.

1. Introduction

The use of effective computing applications in health sectors can make it possible for healthcare providers to monitor and follow

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up patients' health status (Hatch and Cunliffe, 2013). Such applications are commonly used in many developed countries in nursing homes, hospitals, and other related institutions. Additionally, the goal of healthcare services is to provide equitable, efficient, and effective healthcare. With this in mind, earlier studies have suggested improving healthcare service practices by utilizing emerging technologies, thus providing more possibilities to carry out activities necessary for tracking, prevention, detection, and treatment of disease (Rogers, 2010). Thus, information technology (IT) is a primary antecedent to provide efficient healthcare services. Recent consideration of IT solutions like electronic health records systems have helped to prevent typical errors, protect patients' privacy, and provide sufficient storage of patients' data (Jena et al., 2009). The speeding up of innovations involving cloud services has resulted in various implications in healthcare information distribution. However, there are many obstacles that are still facing the establishment of electronic health systems in terms of client assistance, cost, online connectivity, and emergency recovery (Laupacis et al., 1992). Nevertheless, the application of cloud computing in the healthcare sector can provide exceptional advantages for optimizing healthcare services.

Cloud computing could be considered as a solution based on the cloud processing that involves processing and managing healthcare records in a distributed health environment (Philipson and Jena, 2013). More significantly, cloud services provided to organizations could free them from their responsibilities for developing and keeping large-scale internal IT systems; thus, organizations could focus on their main business procedures along with putting into action the promoting application to provide affordable competitive advantages (Byrd and Douglas, 2001). However, even as novel ways for delivering, applying, and processing services represent a revolutionary improvement, it seems that there is limited understanding about low utilization of cloud services in developing countries (Sant'Anna et al., 2007). This may be due to the cloud computing dynamic configuration that provides utility computing, which includes several functionalities that are generally used to manage data in a ubiquitous, distributed, and pervasive way, as well as in supporting many systems, applications, and platforms at independent locations. Furthermore, cloud computing provides exceptional features such as a pay-per-use pattern, ubiquitous network access, self-service, resource pooling, and rapid elasticity. Moreover, it can help in improving the existing practices of service delivery depending on the type of services that can be classified into SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service). A review of the literature revealed that the majority of studies in cloud computing within organizations have focused on the applications of SaaS that are offered to private and public healthcare sectors. On the other hand, PaaS is much more related to the engineering of the software to run these services, while IaaS is associated with the visualization of platform infrastructure.

In Iraq, there is a lack of studies regarding the IT integrity and effectiveness in health organizations (Petersone et al., 2016). Several initiatives have been taken by the Iraqi government to adopt cloud models for optimizing healthcare practices. This includes changing the method for storing patient and other health-related data, thus allowing medical staff to effectively access as well as interpret patients' conditions. On the other hand, Al Hilfi et al. (2013) highlighted that the existing Iraqi health system is facing various obstacles resulting from the loss of health staff in addition to political interference. Meanwhile, these authors pointed out the need for efforts toward reinforcing data quality as data moves up the chain from the facility to the Ministry of Health. Consequently, Cetorelli and Shabila (2014) highlighted the need for the new Iraqi government (after the US-led invasion), together with international donors, to urgently scale up resources and commit to strengthening the network of health facilities. Furthermore, Hameed et al. (2015) acknowledged the current challenges that face the Iraqi healthcare sector in providing medical management services due to the inappropriate utilization of technology in which no procedure is executed for information sharing. Previous studies in the healthcare sector have mostly emphasized the potential for addressing physicians' perception when it comes to clarifying technology utilization and adoption. This is because physicians are the actual users of cloud-based health systems. Although cloud services' integration within health information systems has recently increased substantially, its implementation is still seen as being in its elementary stage, which is more notable as current policies by the Iraqi healthcare sector have addressed the needs of such technologies in order to reduce the socioeconomic disparities within the sector.

Thus, determining the key factors that contribute to the utilization of cloud services in Iraq is essential. This study is concerned with modelling the relationships among the key factors affecting physicians' utilization of cloud services in the Iraqi healthcare sector.

2. Literature review

2.1. Cloud computing in healthcare

Our review of the literature revealed that many organizations can benefit from cloud services, including government agencies, online entertainment companies, financial businesses, and healthcare providers. Considering our research focus and current problems in healthcare services offered by Iraqi hospitals to their citizens, the researchers gave attention to the application of cloud health information systems in Iraq. Cloud information systems provide platforms for healthcare professionals to communicate and share medical data across departments. The literature showed that many health systems were built on work flows that include fragmented IT systems, paper medical records, and duplicated test results; this means that most medical professionals tend not to always have access to information they need when they have to quickly make a decision about patient care. Therefore, cloud computing was found to alter current health management practices in both developing and developed countries.

2.2. Cloud health systems in Iraq

With the latest development in healthcare services, Iraqi hospitals are still lacking access and delivery of medical data across

departments and regions, although their availability is regarded as crucial, in particular under emergency conditions (Sharma and Piachaud, 2011). The current movement to fully utilize cloud health systems in Iraqi hospitals was motivated by the services offered by the cloud platform to resolve these issues. Healthcare organizations are mostly facing management issues around medical data, especially involving the limited availability, recovery, and transfer of medical data. As such, hospitals in Iraq are presently confronted with large quantities of medical data that continually increase due to the number of patients, as well as with recent increased violence in the country (Al Hilfi et al., 2013). Therefore, technological advances represented by the use of cloud health information systems can offer a reliable means for healthcare professionals to communicate and share medical data. In the cloud computing environment, healthcare applications and medical data are meant to be organized and provisioned from servers where enough storage capacity for medical resources is available. It could even permit central storage for medical data to be shared and distributed across departments. On this basis, cloud processing is believed to reduce IT costs for healthcare providers by providing a structured hospital information system for all healthcare members.

2.3. Related studies

Cloud computing utilization/adoption models in healthcare have been proposed by a few researchers to facilitate certain medical purposes. To gain a deeper insight about the current utilization of cloud health systems, the researchers in the present study carried out a literature survey to identify and review the most relevant previous models. For example, Hsieh et al. (2015) proposed a model to explain healthcare professionals' acceptance and resistance prior to implementation of a health cloud system in Taiwan. The researchers integrated technology acceptance and status quo bias perspectives to determine how healthcare professionals' intention to use the health cloud service was associated with their intention to resist it. The authors found that healthcare professionals' resistance was the result of regret avoidance, inertia, perceived value, switching costs, and perceived threat. In addition, the researchers found that attitude, subjective norm, and perceived behavior control affected professionals' intention to use the health cloud. In (2016), Hsieh integrated UTAUT and SQB theory to develop a model of intention to use and resist cloud health services among patients in Taiwan. Hsieh found that the main cause of resistance was sunk costs, inertia, perceived value, transition costs, and uncertainty. Performance expectancy, effort expectancy, social influence, and facilitating conditions were shown to have positive and direct effects on patients' intention to use the health cloud. The study showed the importance of incorporating user resistance in technology acceptance studies in general and health technology usage studies in particular.

Lian et al. (2014) also investigated the critical factors for driving decision makers to adopt cloud computing technology in the Taiwanese hospital industry. They found that the five most critical factors were data security, perceived technical competence, cost, top manager support, and complexity. In (2017), Lian proposed a model for private cloud computing based on certain factors. The result showed the role of trust in the information system for understanding cloud computing success in Taiwanese hospitals. The proposed model was believed to help hospitals evaluate or achieve success after adopting private cloud computing healthcare services. Lian found that information quality, system quality, and service quality were the main predictors of cloud computing satisfaction. These factors also affected users' trust that in turn affected their satisfaction. Ratnam et al. (2014) proposed a cloud adoption model to enhance the Malaysian healthcare sector. They considered factors related to investments and costs of infrastructure, communication, medical-related equipment, and software. AlBar and Hoque (2017) proposed a model for adopting cloud enterprise resource planning by combining the TOE model with the DOI to produce a four-dimensional model consisting of technology, organization, environment, and innovation characteristics domains. The proposed model was believed to offer practical guidelines for the successful adoption of cloud ERP in Saudi Arabia and to assist other developing countries.

These examples are offered to show that different needs, culture, and environments make it difficult to apply a specific model in the situation of the Iraqi healthcare sector. This assumption was further confirmed by Venkatesh and Zhang (2010), who declared that different cultures need to test the existing theory/model in the context of usage. Moreover, it can be concluded that most studies on cloud utilization in healthcare were imposing some limitations related to the factors, context of use, and purpose of use. This was limited to certain developed and developing countries, because no study has been conducted in Iraq. Drawing from the previous models, it can be noted that most studies were examining certain organizational and behavioral aspects according to the current state of technology applied to satisfy certain purposes. From this, the researchers were able to conclude that modelling cloud health information systems in developing and developed countries has yet to be examined—or to date has been examined with only limited inputs. Thus, this study was prompted by a real need to improve healthcare services in Iraq by shedding light on the main antecedents that may affect physicians in their full use of cloud services.

3. Research model and hypotheses development

The literature review reveals that many studies have been conducted on the use of cloud computing by healthcare organizations. Because this study is the first of its kind in the Iraqi context, a preliminary study was conducted to identify the most relevant key factors and to study the current situation (Kadhum and Hasan, 2017; Meri et al., 2017). However, a literature survey was carried out to gather related information regarding the gathered factors and to verify that these factors could be used in in the context of healthcare. The rationale associated with making use of several information sources is to produce comparable results that can improve the validity as well as the credibility of the findings (Fink, 2003). The main contribution of this paper is to model the relationships among external factors and physician's behaviors to be able to fully utilize cloud services in their work spaces. This includes investigating the effect of exogenous variables like system integrity on physicians' confirmation and behavioral control and their impact on the utilization of cloud health information systems among Iraqi physicians. The construction of the proposed model

was theoretically based.

3.1. Theoretical understanding

The study's model is supported by three main theories: organizational theory, diffusion of innovation theory, and the theory of reasoned action. The researchers' review of the literature revealed that these theories could be used to explain the association between the system integrity and individual factors for utilizing cloud computing services in the Iraqi healthcare sector.

Organizational theory (Hatch and Cunliffe, 2013) is made up of four major elements that are assumed to affect the environment: technology, culture, organization structure, and social structure. Understanding these aspects will assist in describing the existing shortage of technology utilization and structure in the Iraqi healthcare sector to utilize cloud computing services. Because this study mainly emphasizes technological aspects, the relation of this theory has been considered in regard to the present study's factors. The relationship between the technological structure and environment is perceived to be an important component for promoting an individual's behavior. Meanwhile, the association between system integrity and changes in one's behavior has been addressed to influence individuals' use of technology. Consequently, it is assumed that an insufficiency of the system can lead to low coordination in the Iraqi healthcare sector.

On the other hand, the diffusion of innovation (DOI) theory by Rogers (2010) is actually used to clarify how technology utilization may drive one's usage of that technology. The theory explores the actual way to exchange ideas among individuals. It also can be used to emphasize how cloud computing adoption is caused by the interaction among individuals via interpersonal networks. Thus, it is believed that innovation to utilize technology is carried out by the communication of various channels within the social system depending on solid relationships among individuals, internal organizational structure, and external organization characteristics. Furthermore, the DOI model indicates that technology diffusion can be affected by technology characteristics including its advantages, trialability, compatibility, complexity, and observability of the end results from implementing the technology.

To explain how individuals' behavior is driven by the function of their intentions to use or adopt technology, the theory of reasoned action (TRA) has been considered (Ajzen and Fishbein, 1980). The TRA role associates healthcare members' behavioral control with their behavioral beliefs as well as adoption of a cloud system. This is mainly evident from the function of TRA in regulating individual behavioral changes to create normative beliefs and also the motivation of complying with the provided services. According to Madden et al. (1992), when an individual perceives that his/her outcome of behavior is positive from certain use, then his/her behavioral control will also be positive toward performing that behavior.

3.2. Hypotheses development

Based on these theories, the researchers constructed an understanding of the relationships among research variables. The following subsections define these factors and their relation to the context of this study, research questions, and the hypothesis for each relationship.

3.2.1. System integrity domain

System characteristics have always been addressed to influence the way in which a person controls his/her task. This is usually characterized by an individual's perception of a system to fulfill certain task demands (Hong et al., 2002). According to Hsiu-Fen Lin (2008), ensuring a successful use of technology requires examining system features as external variables for any adoption regarding driving one's beliefs of its effectiveness and usefulness. However, most previous studies on system characteristics have heavily emphasized the acceptance of a system with regard to other users' characteristics (Yu et al., 2009). As such, the effect of system-related factors on the individual's behavior within the healthcare context has been less discussed. The system's characteristics in terms of compatibility, complexity, data security, and privacy are the main concern of this study. These factors are assumed to drive physicians' perceptions to use cloud-based health information systems and potentially influence their usage behavior. The relationship between system-related factors and health members' control and confirmation are the main scope of this study. This is because there is a need to identify specific system characteristics within the Iraqi context to promote the use of the cloud for accessing and managing health-related matters. Yi-Shun Wang and Liao (2008) stated that as an organization uses advanced systems to deliver services, there is a need for evaluating its impact on users. Meanwhile, the relationships among various system characteristics and behavior may result in different usage experiences and as a result different interest in adopting technology. To be able to understand these effects, the following research question was formulated:

RQ1: What are the effects of system integrity factors in terms of compatibility, complexity, security, and privacy on physicians' confirmation and behavioral control to utilize cloud computing services in the Iraqi healthcare sector?

Hence, the researchers explained each of the proposed factors and their hypotheses as follows:

- **Compatibility**

Rogers (2004) stated that the compatibility of a system refers to how the current system fits the individual's existing values, previous practices, and current needs. In the context of this study, we defined compatibility as the degree to which the cloud health information system is consistent with healthcare professionals' work practices or preferences. The research argues that determining the fit of the health information system and individuals' needs is essential for shaping their usage behavior of the system. However, system compatibility as a key facilitator in the Iraqi healthcare organizations has not been adequately examined. It is unclear which

critical functionality of cloud health information systems can facilitate healthcare professionals' tasks and which design can best fit their needs.

The literature showed that compatibility is an important aspect to consider when examining new technology adoption (Wu et al., 2013). Jen-Her Wu et al. (2007) stated that the compatibility of a health information system significantly influences acceptance by healthcare professionals. This aspect was supported by Hung et al. (2014), who found that system compatibility is the first facilitator to shape a positive IT attitude and usage behavior. Thus, the following hypotheses were formulated:

H1a:. System compatibility of a cloud health information system will have a positive effect on physicians' confirmation of the technology.

H1b:. System compatibility of a cloud health information system will have a positive effect on physicians' behavioral control of the technology.

- **Complexity**

Oliveira et al. (2014) defined the complexity of a system as the degree to which the technology is perceived to be somewhat difficult to understand and employ. It is evident from the literature that utilizing cloud services in the healthcare domain may result in some challenges for those who lack technological expertise as well as IT specialists (Ifinedo, 2011; Thiesse et al., 2011). This is because the easier it is to integrate cloud health information systems into the Iraqi healthcare sector, the greater the chance of its utilization. However, the complexity of new functions and services in the cloud health information system can be challenging to a healthcare professional who lacks technological expertise and IT specialists. Previous studies have examined aspects related to the efficiency of data transfer, system functionality, interface design, and system capacity as the main determinants of a system's complexity. The complexity of a system is associated mostly with how an individual perceives technology to be relevant to self-experience. In addition, it is correlated with users' mental effort necessary to use a system. This may positively influence users' control of the task and actions when processing medical data. On the other hand, the complexity and uniqueness of the system may result in additional behavioral challenges for users to effectively interface with the system (Ellram et al., 1989). This can be due to the direct impact of system complexity on one's expectations and preferences of services. Hence, the following hypotheses were formulated:

H2a:. System complexity of a cloud health information system will have a positive effect on physicians' confirmation of the technology.

H2b:. System complexity of a cloud health information system will have a positive effect on physicians' behavioral control of the technology.

- **Data security**

The ongoing increase in utilizing trending technologies in healthcare practices has resulted in modulating the conventional methods of dealing with patient data (Vincent et al., 2016). In today's healthcare practices, healthcare professionals with multiple privileges need access to patient information using any device/platform at any time in the cloud. As such, the importance of data security in a cloud environment has been extensively discussed recently in many studies. Rong et al. (2013) carried out a literature survey to document the importance of security concerns relating to users' utilization of cloud computing. Security vulnerability can be defined as a threat that results in a condition sufficient to cause damage to a network, resources, or data in different formats. This includes security threats regarding modification of data, destruction, and denial of service, as well as fraud, disclosure, waste, and abuse. Such threats are typically represented by outsiders or insiders when communicating with or accessing the internal network, the communication channel, or the user's personal computer. With cloud computing serving as a convergence of storage and computing in a shared multi-user environment, security concerns are therefore more feasible (Li et al., 2013). In most developing countries, security concerns are always ranked high; from a health perspective, Tieu et al. (2015) stated that users of electronic health systems may not necessarily trust the applied security measures, including the ability of outsiders and other healthcare professionals to access the health information. This may positively affect their confirmation of expectations of the healthcare system, to which scholars like Vincent et al. (2016) addressed the featured security threats faced by users of health systems in a cloud environment. Hence, the role of data security in promoting healthcare professionals' utilization of cloud information system was studied according to the following hypotheses:

H3a: Security of a cloud health information system will have a positive effect on physicians' confirmation of the technology.

H3b: Security of a cloud health information system will have a positive effect on physicians' behavioral control of the technology.

- **Data privacy**

Privacy, a major impediment to the use of healthcare systems as acknowledged by many previous studies (e.g., Duquenoy et al., 2012; Kalogridis and Dave, 2014; Sahama et al., 2013), represents the control of medical data between healthcare professionals and others. A security breach is an incident in which an organization may experience loss in personal records, people information, or other sensitive data (Milutinovic and De Decker, 2016; Zhou et al., 2010). Privacy concerns are typically associated with the security of information that mainly involves unauthorized access by external entities, which poses one of the biggest challenges for e-health

systems. This concern has been discussed in different developed and developing countries as the major challenge in allowing healthcare professionals to access patient data. In the context of the healthcare sector, medical data privacy is seen as the extent to which information about healthcare professionals and patients is communicated to others. Soceanu et al. (2015) stated that the privacy of medical data may positively affect the way healthcare professionals perceive the system to be sufficient and usable for sensitive medical cases. This perception is believed to drive healthcare professionals' confirmation and perceived control of a system. However, Gajanayake et al. (2013) discussed ongoing issues of using health management systems with regard to patient privacy in terms of information use by authorized entities. Hence, previous studies have recommended examining data privacy concerns when it comes to technology utilization in healthcare settings (Sahi et al., 2016). As such, the following hypotheses were formulated:

H4a:. Privacy of a cloud health information system will have a positive effect on physicians' confirmation of the technology.

H4b:. Privacy of a cloud health information system will have a positive effect on physicians' behavioral control of the technology.

3.2.2. Individual domain

The general understanding of individual domain includes characteristics of people regarding the context of a study (Csikszentmihalyi and Sawyer, 2014). People characteristics can be studied from a demographical or behavioral perspective. The individual domain is one of the key elements that assesses people's adoption of technology. Previous studies like those of Gudienė et al. (2014) linked individual factors to the success of an organization by contributing to one's perception and attitude in a workplace. The individual domain in this study is defined as the extent to which physicians perceive the use of a health information system to promote their control and confirmation to their abilities. In the healthcare context, individual factors have always been regarded as the main driver of the belief (Lozano et al., 2013). However, the impact of such beliefs on healthcare members' adoption of cloud-based health information systems is yet to be studied. Additionally, the positive perception of individuals to maintain particular usage behavior creates a feeling of responsibility and attachment that makes them indebted to the task (Ahimbisibwe et al., 2015). As a result, it is believed that such feeling would result in an atmosphere for healthcare members to act with control and confirmation. Under such circumstances, positive attitudes can be developed by using a cloud-based health information system to carry out certain role behaviors among physicians of Iraqi hospitals. Therefore, the following research question was formulated:

RQ2: What are the effects of individual factors in terms of confirmation and behavioral control on physicians' utilization of cloud computing services in the Iraqi healthcare sector?

- **Confirmation**

Bhattacherjee (2001) identified confirmation as the perception of the congruence between expectation to use new technology and its actual performance. Confirmation is an important factor that describes one's cognitive belief derived from prior use of technology, which can influence subsequent technology use through other environmental factors. Roca et al. (2006) stated that expectation–confirmation can predict individuals' utilization of technology. According to Sørebø et al. (2009), the confirmation of an individual's expectation toward a service or feature can be associated with his/her usage experience to the extent that favorable characteristics would positively drive the utilization and adoption. Larsen et al. (2009) explained how users' confirmation of a technology can promote their motivation to continue using it with regard to other environmental and personal characteristics. In addition, previous studies have showed the direct association between users' behavioral confirmation of certain technology with their acceptance and utilization of a system (Lin and Wang, 2012). Hence, the researchers in this study considered the ultimate role of expectation confirmation of physicians in Iraqi hospitals on their utilization of a cloud health information system. Based on this, the following hypothesis was formulated:

H5: Confirmation toward a cloud-based health information system will have a positive effect on physicians' utilization of the technology.

- **Behavioral control**

Behavioral control is quite related to the self-efficacy term and involves the control perception over the performance of a behavior. It refers to the beliefs one may attain from the normative expectations of technological utilization to comply with normative beliefs that may facilitate performance of the behavior for better control (Ajzen and Madden, 1986). Cloud health information systems may impose a certain level of complexity, which makes it difficult for users to take the necessary actions in a certain situation that reflects the external locus of control over extraneous factors (Bhattacherjee et al., 2008). Parikh and Verma (2002) asserted that in order for an organization to ensure a successful utilization of technology, it needs to ensure that users pose an adequate level of control; lower control may result in dissatisfaction and reduce system usage. Hence, the organization needs to ensure that the system is accompanied by instructors to encourage and assess users in system use. Thus, the researchers examined the role of different system-related factors in regulating physicians' control of a cloud health information system in Iraq. The following hypothesis was formulated:

H6: Behavioral control toward a cloud-based health information system will have a positive effect on physicians' utilization of the technology.

Fig. 1 illustrates the hypothesized proposed model for this study.

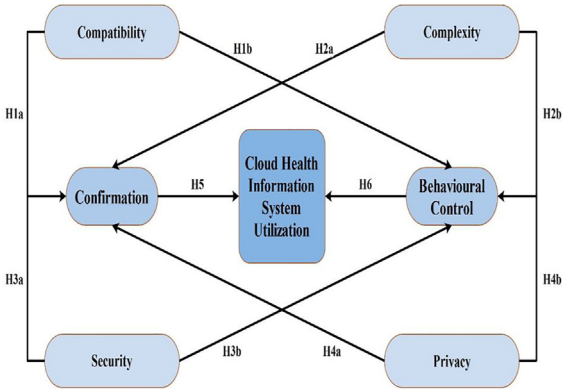

Fig. 1. Proposed hypothesized research model.

4. Research methodology

This study is concerned with modelling the relationships among the key factors affecting physicians' confirmation and behavioral control toward utilizing cloud health information systems in the Iraqi healthcare sector. Sekaran and Bougie (2016) highlighted the need to select the most appropriate research approach and design that can solve the research question(s). Therefore, a quantitative research approach has been adapted. This research was deemed to be descriptive, correlational, involving an individual's unit of analysis, cross-sectional, predictive, and deductive. Surveys are considered to be an effective component for gathering information on the grounds that they permit a scientist to precisely focus the prerequisites and estimations of variables (Sekaran and Bougie, 2016).

A questionnaire technique was used to determine physicians' views about the validity of the research variables. The main reason for choosing a questionnaire was its feasibility in simplifying the analysis of the data more scientifically and objectively than with other forms of research. In addition, it can also help researchers to compare and contrast other research and may be used to measure change positivists believe for examining existing hypotheses. The researchers in the present study followed systematic methodological phases based on the recommendations of Sekaran and Bougie (2016) and Creswell (2013), as described in the following subsections.

4.1. Instrument development

Before starting the questionnaire, respondents were presented with a brief description of the research study aims and focus to adequately answer the questionnaire items. This was followed by some demographic questions to gain insight about the respondents' background. The instruments were designed based on the content of each factor. Specifically, the instrument was a closed-ended questionnaire based on 5-item Likert scales (Likert, 1932), in which respondents needed to provide a specific answer for each item. Developing the research instrument was based on adapting the items related to each variable from a variety of previous studies (see Appendix A).

All survey instruments were reviewed by five experts in the field of information systems, cloud computing, social sciences, e-health, and health information systems adoption, as well as one physician from an Iraqi hospital who is also a lecturer in a faculty of medicine (University of Mustansariah, Baghdad, Iraq), in order to determine their validity and clarity within the context of this study. The survey instruments were modified slightly based on their feedback. Then the questionnaire was translated from English to Arabic (back-to-back translation); Arabic is the official language in Iraq.

Before conducting the survey, we invited 35 physicians who have experience in using cloud-based health information systems to check the reliability of the instrument and make sure it was free of error and could fit the Iraqi context. The pilot study results showed that the internal consistency reliability (in terms of Cronbach's alpha coefficient) achieved the reliable threshold of 0.7 (Hair et al., 2016); values had the range of 0.709–0839.

4.2. Data collection procedure and sampling

This study targeted a population acquired from the Iraqi public health sector located in Baghdad Governorate (capital city of Iraq). The main reason for this choice relates to the functionality and reliability of the adopted technology when compared to other Iraqi states. In Baghdad, there are about 39 public hospitals. However, just four general hospitals were chosen: Baghdad Teaching Hospital, Al Kindi General Teaching Hospital, Al-Yarmouk General Teaching Hospital, and Al-Karkh general hospital. They were chosen because of their capability and capacity to offer various healthcare aids. Furthermore, they followed the suggestion of the state healthcare director in Baghdad Governorate via a filtering procedure in terms of the number of physicians, beds, patients, and medical cases. The study population involved 304 physicians in these hospitals who were aware of cloud services. Data collection was performed using an online survey and was administered in Arabic. The survey was available on a website for a period of about three months. This study used a simple random sampling technique, in which the researchers randomly selected the respondents from the

target population, because of the flexibility and generalizability offered by this method. In the unrestricted probability sampling design, all of the population elements have equal and known possibility to be chosen as a sample subject. This sampling technique has the lowest bias and offers the most generalizability. On the other hand, this sampling method could become cumbersome and expensive (Sekaran and Bougie, 2016).

In total, 259 responses were received, giving a response rate of 85.2%. We deleted 20 responses due to missing data, and another 28 responses were eliminated as outliers. Additionally, the data set was checked for normality distribution using skewness and kurtosis measures; we found that the standard error values were 0.135 for skewness and 0.175 for kurtosis. In addition, the skewness values for the physicians' constructs ranged between −1.121 and −2.153, while the kurtosis values ranged between 1.398 and 5.633, leading us to conclude that such variations in the distribution were typically normal. Finally, a collinearity check was performed using variance inflation factors (VIF). The results revealed no serious problem with multicollinearity for all constructs; VIF values ranged between 1.301 and 1.624.

4.3. Data analysis

The collected ordinal data was analyzed using the partial least square structural equation modelling (PLS-SEM) technique as a nonparametric second-generation multivariate analysis. This was mainly to assess the measurement instrument psychometric properties and to statistically test the proposed hypotheses in the research model (Hair et al., 2016). PLS-SEM is much more appropriate for research on technology acceptance that emphasizes predictive modelling (Venkatesh and Bala, 2008; Venkatesh and Davis, 2000). Compared with CB-SEM (covariance based), the PLS approach is suitable for incremental studies, i.e., constructing new measures and structural paths, particularly in information systems research (Hair et al., 2011). Therefore, PLS-SEM was appropriate for this study, which involved constructing new structural paths. The Smart-PLS statistical software package version 3.0 (Ringle et al., 2015) was used to run the analysis to validate the structural model after confirming the appropriateness of the measurement model.

5. Results

5.1. Demographic characteristics

Table 1 presents the demographic statistics for the respondents. Approximately 65.9% were males, and 34.1% were females. The majority of respondents (41.2%) were between 25 and 30 years of age. In terms of educational level, the majority of respondents (66.3%) held a bachelor's degree. A majority (66.8%) had 1–2 years of experience using cloud health systems, while 22.7% had 2–4 years and 10.4% had > 4 years of experience.

5.2. Measurement model analysis

Based on the recommendations of Hair Jr. et al. (2016), a measurement model assessment in an essential step in the PLS approach, as it helps to advise that a number of observed indicator variables may be unreliable, which restricts the researcher to move into analyzing the structural model. Analysis of the reflective measurement models involves checking the composite reliability and Cronbach's alpha to be able to evaluate internal consistency, individual indicator reliability and communality, and average variance extracted (AVE) in order to evaluate convergent validity. Furthermore, the Fornell-Larcker criterion and Heterotrait-Monotrait (HTMT) tests were used to examine discriminant validity.

Table 2 presents the results of the convergent validity as the first step in assessing the measurement model. First, for the items

Table 1
Descriptive statistics of demographic factors.

Demographic factors	Frequency	%
Gender		
Male	139	65.9
Female	72	34.1
Age (Years)		
25–30	87	41.2
31–35	57	27.0
36–40	41	19.4
> 40	26	12.3
Education		
High diploma	0	0
Bachelor	140	66.3
Master	41	19.4
PhD	30	14.2
Experience with the health information system? (Years)		
1–2	141	66.8
2–4	48	22.7
> 4	22	10.4

Table 2
Results of the measurement model: convergent validity.

Constructs	Indicators	Item Loading	Item Communality	Cronbach's Alpha	Composite Reliability	AVE
		> 0.7	> 0.5	> 0.7	> 0.7	> 0.5
Compatibility (COM)	COM1	0.833	0.693	0.926	0.941	0.694
	COM2	0.859	0.737			
	COM3	0.811	0.657			
	COM4	0.847	0.717			
	COM5	0.810	0.656			
	COM6	0.859	0.737			
	COM7	0.809	0.654			
Complexity (CP)	CP1	0.807	0.651	0.869	0.911	0.719
	CP2	0.869	0.755			
	CP3	0.875	0.765			
	CP4	0.838	0.702			
Security (SEC)	SEC1	0.856	0.732	0.925	0.947	0.816
	SEC2	0.938	0.879			
	SEC3	0.901	0.811			
	SEC4	0.916	0.839			
Privacy (PRV)	PRV1	0.812	0.659	0.898	0.919	0.620
	PRV2	0.792	0.627			
	PRV3	0.795	0.632			
	PRV4	0.725	0.525			
	PRV5	0.821	0.674			
	PRV6	0.732	0.535			
	PRV7	0.829	0.687			
Confirmation (CFP)	CFP1	0.879	0.772	0.839	0.903	0.757
	CFP2	0.879	0.772			
	CFP3	0.852	0.725			
Behavioural Control (BCP)	BCP1	0.753	0.567	0.899	0.925	0.713
	BCP2	0.871	0.758			
	BCP3	0.869	0.755			
	BCP4	0.846	0.715			
	BCP5	0.876	0.767			
Utilization (UTP)	UTP1	0.850	0.722	0.826	0.896	0.742
	UTP2	0.868	0.753			
	UTP3	0.866	0.750			

level, the analysis shows that the indicator loadings and communality surpassed the threshold levels of 0.7 and 0.5, respectively. Secondly, the constructs level analysis shows that Cronbach's alpha, composite reliability, and AVE surpassed the threshold levels of 0.7, 0.7, and 0.5, respectively, which indicates that the convergent validity was met. Consequently, the Fornell-Larcker analysis shows that the square root of the AVEs for each construct was greater than the correlations with other constructs (see Table 3). Thus, the discriminant validity of all constructs was established. Likewise, all HeteroTrait-MonoTrait (HTMT) values were lower than the threshold of 0.85 (Henseler et al., 2015), which confirms discriminant validity (see Table 4). As a result, both convergent and discriminant validity was met, which allowed us to proceed to assess the structural model.

Table 3
Fornell-Larker criterion test.

	BCP	CFP	COM	CP	PRV	SEC	UTP
BCP	**0.844**						
CFP	0.620	**0.870**					
COM	0.527	0.622	**0.833**				
CP	0.490	0.534	0.473	**0.848**			
PRV	0.558	0.466	0.422	0.323	**0.787**		
SEC	0.484	0.588	0.329	0.411	0.356	**0.903**	
UTP	0.579	0.585	0.464	0.500	0.468	0.452	**0.861**

Notes: Diagonal and bold values are the square root of AVE in between constructs and their indicators. While non-diagonal values are correlations between constructs.

Table 4
HTMT results.

	BCP	CFP	COM	CP	PRV	SEC	UTP
BCP							
CFP	0.711						
COM	0.573	0.702					
CP	0.554	0.623	0.527				
PRV	0.614	0.529	0.456	0.359			
SEC	0.520	0.667	0.352	0.454	0.389		
UTP	0.671	0.701	0.529	0.590	0.535	0.515	

5.3. Structural model analysis

A bootstrapping test was performed with 5,000 resamples to determine the significance level of the path relationship between the exogenous and endogenous latent variables (see Table 5). In the PLS-SEM approach, the bootstrapping test assesses the significance level by determining the t-statistics, path coefficient (β), and probability of error level (p-value) for each path in the structural model (Hair et al., 2006; Sarstedt et al., 2017). The overall power (R^2) indicated that the model accounted for 58%, 49%, and 41% of confirmation, behavioral control, and cloud utilization, respectively. On the other hand, the Q^2 was 0.409, 0.326, and 0.288 for confirmation, behavioral control, and cloud utilization, respectively, which verifies the predictive relevance of all endogenous constructs in the structural model. Such explanatory power and predictive relevance substantiate the model's predictive validity (Hair et al., 2016). Additionally, the bootstrap confidence intervals can also be reported, to examine if a path-coefficient is significantly different from zero. It provides information on the estimated coefficient stability by providing a range of possible population values for the parameter depending on the variance in the data and the sample size. When the estimated path coefficient confidence interval doesn't contain zero value, the hypothesis then rejected for the path equals zero, and a significant effect is assumed (Hair et al., 2016).

Our examination of the results using PLS-SEM led us to clearly validate the initial assumptions for this study. After screening and cleaning the data for any potential reading errors and extreme distributions of some responses, we were able to assess the structural model of the PLS-SEM method to test the hypotheses. The testing results were supported by the nature of the effect (positive or negative) and its strength. We found that all constructs of system compatibility, complexity, security, and privacy showed positive and significant effects of the physicians' confirmation with a path of 0.371, 0.173, 0.349, and 0.129, respectively, explaining 58% of physicians' confirmation variance. The results also showed positive and significant effects of these constructs on the physicians' behavioral control with a path of 0.231, 0.188, 0.216, and 0.323, respectively, explaining 49% variance of the physicians' behavioral control. Moreover, the statistical analysis results showed a positive and significant effect of physicians' confirmation and behavioral control on the utilization of a cloud health information system with a path of 0.368 and 0.350, respectively, explaining 41% of the physicians' utilization construct. From these results, it can be concluded that cloud computing services in Iraq can offer significant potential for physicians by allowing them to manage and share various medical records across departments.

6. Discussion

The main objective of this study was to model the relationship among the key factors affecting physicians' behaviors to utilize cloud health information systems in Iraq. Drawing on the statistical analysis findings, it is evident from Table 5 that compatibility, complexity, security, and privacy were found to positively and significantly affect physicians' confirmation and behavioral control. Whereas, the latter were found to positively influence the physicians to utilize cloud computing services.

The first research question can be answered through the hypotheses H1a, H1b, H2a, H2b, H3a, H3b, H4a, and H4b. The results showed that system compatibility had a significant positive effect on physicians' confirmation (H1a) and behavioral control (H1b) of

Table 5
Bootstrapping path coefficients for physician's model.

Hypothesis		Path coefficient (β)	t- statistics	p-value	95% Confidence Intervals	
					Lower bound	Upper bound
H1a	COM - > CFP	0.371	5.904	< 0.001	0.175	0.503
H1b	COM - > BCP	0.231	3.43	< 0.001	0.233	0.519
H2a	CP - > CFP	0.173	2.391	0.008	0.118	0.341
H2b	CP - > BCP	0.188	2.441	0.007	0.260	0.472
H3a	SEC - > CFP	0.349	5.949	< 0.001	0.057	0.309
H3b	SEC - > BCP	0.216	2.937	0.002	0.055	0.293
H4a	PRV - > CFP	0.129	2.45	0.007	0.213	0.440
H4b	PRV - > BCP	0.323	4.739	< 0.001	0.047	0.219
H5	CFP - > UTP	0.368	4.349	< 0.001	0.099	0.342
H6	BCP - > UTP	0.350	3.537	< 0.001	0.250	0.444

cloud systems in Iraqi hospitals. This can be due to the nature of cloud architecture in which physicians have to deal with the user side to process and share medical data across departments. This is also evident from Kerwin and Madison (2002), who asserted that lack of system compatibility across healthcare organizations and web-based users is a significant element that needs to be considered when attempting to integrate modern technology. Our finding extends previous works like that of Sean S. Smith (2002) on how software compatibility can be associated with an individual's behavior regardless of the case complexity and environmental settings. In addition, it is believed that lack of system compatibility in Iraqi hospitals may potentially result in a significant barrier to complete realization of merging medical data across departments.

As for H2a and H2b, the results showed that the complexity of the health system had a positive effect on physicians' confirmation and behavioral control. This is probably due to the fact that physicians in general perceived the functionalities of the cloud system to drive their behavioral factors and control their work. Our result regarding the effect of system complexity on behavioral control is in line with the work of Hasan (2007), who examined the relationships among system elements and individuals' behavioral changes in a cooperative setting. It also extends the effort of De Groot and Reunis (2005) on how the complexity of the system can regulate one's behavioral confirmation to process different tasks. Yet the literature showed little evidence about the direct effect of system complexity on physicians' confirmation. For example, H. Carrie Chen et al. (2015) wondered how individuals' perception of complexity can drive their behavioral confirmation based on their expectations set within the environmental setting. In addition, we think that both aspects of complexity and expectations are inherent in the notion of effective utilization of technological advances. This is because the complexity of a system and its cost may rise depending on the type of service and user demands to process and manage medical records.

The results of the analysis showed that the security of a cloud system had a significant positive effect on physicians' confirmation (H3a) and behavioral control (H3b) of the technology. This can be due to the fact that physicians were mostly perceiving cloud technology to provide them with a secure platform to communicate and share relevant health data. This finding is relevant to the work of Mittelstadt et al. (2013), who emphasized the importance of system security in regulating people's behavioral norms to use and adopt technology in different settings. This process has been reported to balance the data security and user convenience or control (Barkhi et al., 2008), which has yet to be investigated within the healthcare setting. Meanwhile, behavioral control represents the perception of the absence or presence of requisite resources needed for performing a behavior. This is where the security features of the system can be considered as a key driver of that perception. Therefore, we assume that studying the relations between cloud security and behavioral determinants can potentially unlock some avenues for future development within the healthcare context. On the other hand, physicians in Iraqi hospitals must feel that they have substantial control over the resources and operational conditions important to their technology use. As with this study, this control would properly be associated with the support from the system by providing the security settings for physicians to be able to perform their job.

As observed, results for H4a and H4b showed that system privacy had a positive effect on physicians' confirmation and control. This is normal, as the privacy issues related to patients' health records are some of the most often studied human-centered issues because online systems by nature allow sharing and distributing data across spaces. According to Angst and Agarwal (2009), individuals' concern for information privacy can potentially influence their attitude and intention to use technology. Our finding about the effect of privacy on behavioral control of the physicians is relevant to some previous works, including one by Agaku et al. (2014), who studied the relationship between privacy perception and healthcare users over the collection and use of personal medical information. It also extends the work of Arcand et al. (2007) on how an institution can perceive the privacy of the data over their control. However, our review of the literature showed very limited work on the effect of system privacy on behavioral confirmation. Privacy-enhancing technologies such as the cloud would be an important assist to Iraqi hospitals. We think that perceived control can increase trust in using cloud systems among physicians in Iraqi hospitals and have an important influence on their overall utilization of the technology. We also believe that providing up-to-date privacy protection policies for the cloud system can contribute to physicians' behavioral confirmation and use in different management and sharing activities.

The second research question concerns the effects of physicians' confirmation and behavioral control on their utilization of a cloud health information system. The results for H5 revealed that physicians positively perceived the use of cloud systems as a medium that meets their expectations. This is evident from Hill (2012), who claimed that confirmation of healthcare professionals can be regulated by the degree to which they perceive a tool or system to be relevant to their task and environmental setting. Our finding extends the work of Yeh et al. (2013), who studied the effects of various online system factors based on the expectation confirmation model on users' confirmation of the technology. It also adds some nightfall inputs to the role of cloud systems in increasing physicians' expectations of modern information and communications technology (ICT) in managing their health-related tasks.

As for the effect of behavioral control from using cloud systems on the utilization of the technology (H6), we found that physicians mostly had a positive reaction to the cloud system as it allowed them to securely share and manage medical information with others. In the healthcare setting, physicians are required to be actively engaged in providing a timely and accurate diagnosis to patients, which can sometimes be delayed due to limited resources for making decisions. As such, it is assumed that when physicians use a cloud system, they will be able to effectively make decisions on health conditions that could influence their behavioral control on the environment. Fig. 2 shows the findings using PLS structural modelling.

Despite the fact that several variables of the model were adapted from previous studies, the research model is unique because it was based on real-world issues that have been investigated in the healthcare sector before proposing the model. Compared to the closest previous models that have been designed for using and adopting cloud computing in the healthcare sector, we found that this study's proposed model is different than others because the proposed variables were not described and combined well in previous models; further, the combination of domains and theories is new. For these reasons, the proposed model of this study was designed to

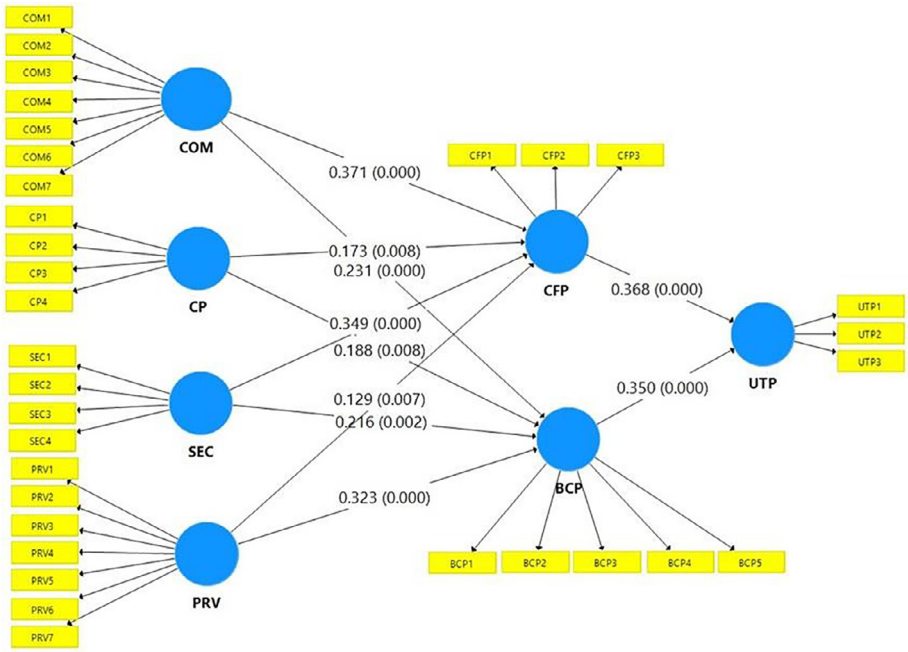

Fig. 2. Results of PLS structural model analysis (Smart-PLS snapshot).

fill the gap on utilizing cloud health information systems by focusing on the Iraqi healthcare sector. The model can also be used to study the utilization of other technological innovations in the healthcare context. In comparison with some other models created to utilize cloud health services, the offered model is the most comprehensive one, as it considers the system aspects to influence physicians' behavioral aspects toward utilizing cloud services. The most relevant cloud health models mentioned earlier were designed for different environments and situations in various countries with different theories and factors. As a result, the combination of proposed factors had not been discussed previously in the literature, and the behavioral aspects of physicians in utilizing cloud health information systems had received limited coverage in literature; this gave further novelty to the proposed study model. Based on Rogers (2003), the research field of innovation adoption is still not mature. Rogers pointed out that a vast majority of the studies in the field of innovation diffusion have focused only on the characteristics of the innovation, and the number of studies that have considered various aspects of the context are limited. From this perspective, this study fills a gap that exists in the literature and contributes to the field of study by indicating several factors that were significantly related to the use of cloud health systems. The findings extend the international studies looking at physician behaviors in utilizing cloud systems. Generally, physicians in developing countries that are mostly using cloud systems have been found to have graduated from foreign universities, where IT systems were accepted as an important part of the healthcare sector.

7. Conclusions, implications, limitations, and future research

The researchers were motivated to explore the relationships among system factors—compatibility, complexity, security, and privacy—on physicians' confirmation and behavioral control, as evidence has shown the real need to improve the utilization of cloud information systems in healthcare services in Iraq. System compatibility and complexity, secure medical information sharing, and information privacy positively influence physicians' confirmation and behavior of using a cloud health information system. A unique model of improving the utilization of a health information system has been developed. By understanding the factors enhancing the utilization of a cloud health information system, the system developer can consider these factors during the system development process. Further, the system developer needs to engage physicians in the development and implementation phases to enhance the system functionality and usefulness. These practices will help to maintain effective communications between the health care providers and ensure the continuity of patient care in Iraq. Therefore, the study model provides the insight that policy makers must identify the positive influential antecedents that affect physician behavior and confirmation, and must ensure that the available system has considered all of these factors for better utilizing the cloud information system in Iraq. Thus, hospital management must channel resources, provide training, and ensure users' engagement before the implementation of a system to achieve better usage in practice.

This study has many limitations. For instance, the data collection was done in Iraq, which is a developing country; thus, the results may not be applicable to other developing countries unless investigating the new environments of usage/adoption, which is an interesting direction. Also, the sample was limited to physicians who were selected using a simple random sampling method. Furthermore, the study used cross-sectional data, so it is difficult to determine temporal relationships. Despite the fact that using

longitudinal data may provide a robust generalization, it may provide a measure for showing an increase, decrease, or even change in respondents' perceptions over time, because cloud technology is being continuously developed. This study also explored certain factors associated with system integrity, behavior, and utilization. Therefore, to begin address these limitations, it is recommended that future researchers consider examining other cultural, organizational, and technical factors by extending the research model. Moreover, it is believed that investigating the perceptions of healthcare staff from different perspectives may result in more reliable conclusions. It would also be interesting to investigate how physicians in rural areas would perceive the use of cloud systems. Therefore, future research may use sophisticated sampling techniques (e.g., multistage cluster sampling or even mixed sampling) to make sure that the results are generalizable, and this would help decision makers in the Iraqi healthcare ministry to see how modern ICT services are used across places. The limitations of this study thus provide a direction for future research that could be applied in different contexts and developing countries.

Conflict of interest

The authors declare that they have no conflict of interest.

A. . Measurement scales

Compatibility	Adapted from Moore and Benbasat (1991) and Tehrani and Shirazi (2014)
COM1: I think using cloud computing fits well with the way our hospital usually performs	
COM2: Using cloud computing fits into our hospital's work style	
COM3: Using cloud computing is compatible with our hospital's norms and culture	
COM4: Cloud can easily be integrated into our existing IT infrastructure	
COM5: Cloud computing is NOT compatible with other systems that we are using	
COM6: In order to use cloud computing, we do NOT need to technically change anything	
COM7: Using cloud computing is compatible with all aspects of our work	
Complexity	Adapted from Ifinedo (2011); Moore and Benbasat (1991); Oliveira et al. (2014); Thiesse et al. (2011)
CP1: The use of cloud computing requires a lot of mental effort	
CP2: The use of cloud computing is frustrating.	
CP3: The use of cloud computing is too complex for business operations	
CP4: The skills needed to adopt cloud computing are too complex for employees of the hospital	
Security	Adapted from Tehrani and Shirazi (2014)
SEC1: Cloud computing provides a secure service	
SEC2: Cloud providers' servers and data centers are secure	
SEC3: The media that is used to transmit our data to providers' data center is secure	
SEC4: Overall, I do not have any concern about the security of cloud computing services	
Privacy	Adapted from Dinev and Hart (2006); Tehrani and Shirazi (2014)
PRV1: I am concerned that the information I submit to health information system could be misused	
PRV2: I am concerned that a person can find private information about me when using the health information system	
PRV3: I am concerned about providing personal information to other hospitals, because of what others might do with it	
PRV4: I am concerned about providing personal information to other hospitals because it could be used in a way I did not foresee	
PRV5: Cloud providers maintain the privacy of our data we are using	
PRV6: Cloud providers maintain the confidentiality of our data	
PRV7: Overall, I do not have any concern about the privacy of cloud computing services	
Confirmation	Adapted from Bhattacherjee (2001)
CFP1: My experience with using cloud services in health information system was better than what I expected	
CFP2: The service level provided by cloud services in health information system was better than what I expected	
CFP3: Overall, most of my expectations from using cloud services in health information system were confirmed	
Behavioural control	Adapted from Taylor and Todd (1995)
BCP1: Using cloud services in health information system was entirely within my control	
BCP2: I had the resources to use cloud services in health information system	
BCP3: I had the knowledge to use cloud services in health information system	
BCP4: I had the ability to use cloud services in health information system	
BCP5: I would be able to use the cloud services in health information system well for managing my works	
Cloud Health Information System Utilization	Adapted from Davis (1989) and Magid Igbaria et al. (1996)
UTP1: I will use the cloud services in health information system on a regular basis in the future	
UTP2: I will frequently use the cloud services in health information system in the future	
UTP3: I will strongly recommend that others use it	

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tele.2018.12.001.

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