ISSN 2278-3091
Volume 10, No.2, March - April 2021
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse891022021.pdf
https://doi.org/10.30534/ijatcse/2021/891022021

Towards A Cloud Computing Success Model For Hospital Information System In Jordan

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ABSTRACT

Cloud computing technology success has yet to develop from the infancy stage of implementation in the context of hospitals. This study primarily aimed to minimize the literature gap by examining the critical factors influencing cloud computing success in hospitals, particularly in Jordan. The study made use of online survey method for data collection, and the survey were distributed to chief information officers (CIOs) in the hospitals. Based on the obtained results, the inclusion of trust, networking quality and perceived risk into the information system model will contribute to the explanatory power of cloud computing success in Jordanian hospitals. In added, system quality, information quality, networking quality, service quality and trust were found to have a direct influence on cloud computing satisfaction, while risk was found to indirectly influence satisfaction via trust. Trust mediated the relationship between perceived risk and satisfaction. The proposed cloud computing success model is expected to assist hospitals in their evaluation and achievement of success following their cloud computing adoption in healthcare services.

Key Words: Cloud Computing; Critical Success Factors; Hospital Information Systems, Information Systems Success.

1. INTRODUCTION

In the current times, Information and Communication Technology (ICT) has experienced an increasing focus in digital transformation in the context of Jordan, for the country to keep abreast of the developments and progress of different fields. In particular, several key digital transformation initiatives have been proposed in the Hospital Information System (HIS) sector, as exemplified by the Hakeem healthcare system [1, 2]. HIS generally encapsulates Laboratory Information System (LIS), Radiology Information System (RIS), Ultrasound Information System (UIS), among other information systems in the hospitals. The development of HIS in Jordan can be attributed to different affairs and activities in the hospitals including storage, digital acquisition, management, and transport of medical information. To date, the Computer-based Patient Records (CPR), Picture Archiving and Communication System (PACS) and several other technologies have been adopted in an extensive manner in the hospitals, albeit they incur high costs and time consumption.

In fact, owing to the significant ICT services costs and high time consumption, the government of Jordan has shifted to investing in cloud computing in digital transformation of business administration and services provision [3]. Accordingly, the Jordanian government healthcare has brought forward its cloud computing platform, one that is private and primarily aimed at minimizing the costs of ICT service while being reliable and flexible [4, 5]. Additionally, it enables the users to identify the needs of their infrastructure like servers and software electronic form and high speed without providing the required space, software, and purchase servers [4-6].

More specifically, Cloud Computing represents a new ICT paradigm that addresses and provides applications and services that are accessible online at any time and place, for the purpose of data sharing, management, and storage, hosted by remote servers rather than using personal devices or internal resources [3, 7, 8]. Moreover, CC may also be referred to as Internet-based computing [9], offering several shared computing resources like networks, services, servers, software applications and storage applications that are accessible throughout computers and devices through the Internet, enabling the user to avail of the services in a safe, low-cost manner, without much stress on its management and maintenance [10, 11]. In other words, using CC technology in Jordanian HIS can enable lowering of costs attributed to ICT services spending and offers flexibility to access to the needed computer resources [12, 13]. Furthermore, CC is Green IT, which makes it an environmentally friendly technology that minimizes the used devices and servers and whose usage will lead to energy conservation [14, 15].

Nevertheless, in the Middle Eastern countries, including Jordan, CC has not yet permeated the healthcare organizations and is still in its infancy phase. Thus, the present study primarily aims to examine the critical factors

affecting cloud computing success in Jordanian hospitals in order to develop and propose an HIS model.

2. LITERATURE REVIEW

2.1 Cloud Computing (CC)

Cloud Computing (CC) has been described in many studies in literature; for instance, [16] defined CC as a dynamic ICT paradigm, offering demand computing resources to use over a network infrastructure, while [17] referred to CC as a novel ICT form that is dependent on the virtualization and resources concept like hardware infrastructure, software, and data, disseminated via the Internet as a service model provided by the service provider. According to Padhy et al. [18], CC is a 5th generation computing following mainframe, personal computer, client-server computing and the Internet. Technically, Buyya et al. [19] proposed an approach concerning CC as a type of parallel and distributed system that comprises of a set of virtualized computers – a system which dynamically offers resources, with Service Level Agreement (SLA) agreed upon between the client and the service provider.

Based on the above description, CC forms the technical basis for cloud services, which offers solutions to consumers and businesses that are used through real-time Internet. CC is technologically based on infrastructure, system software, application development, deployment software, system and application management software and IP-based network services. CC has been extensively adopted in the levels of organizations and individuals.

There are three major services offered by CC, namely Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS) [16, 20]. More specifically, SaaS involves the offering of software products by the major cloud providers to the users through the Internet, and it is accessible at any time and place using a device. PaaS involves the cloud users offering of the facilitation of an environment for the creation and deployment of custom applications, and thus, users' infrastructural requirements are taken care of and they can control the applications. On the other hand, IaaS involves the offering of computing resources and storage to the users for a specific fee – and such resources include CPU, memory, storage, and network bandwidth can be accesses by many users at the same time for sharing. Sharing of pooled resources among many users is referred to as multi-tenancy. Accordingly, cloud computing deployment models are four and they are; private, public, community and hybrid clouds [21]. In particular, private clouds are organization-owned for the staff to manage and are often employed by in-house experts or out-source to external entities. This model is the most secured among the existing models. Comparatively, a public cloud is major CSPs-owned, those with massive cloud infrastructure spreading throughout continents at times, offering services on-demand, in a multi-tenant and virtualized way, for a certain fee. This model is not as secure as the first one and it is manageable by the community or another party. Hybrid clouds leverage reap the advantages that private, public/community clouds provide as it is a combined version of them, with unique entities but are enabled to share cloud infrastructure [16, 21].

Oftentimes, cloud users are most concerned about the Quality of Service (QoS) that Cloud Service Providers (CSPs) provide and such provision of services is not easy as CSP has to identify the optimum hardware and software configurations that will be appropriate for the user's QoS, while guaranteeing that the resources are optimally utilized [16, 20].

2.2 Cloud Computing in HIS

In the current healthcare sector, CC technologies are on the rise with the demand among hospitals increasing as time passes [22]. Healthcare sector is a dynamically growing sector brought about by the increase in the demand for delivering the top medical services at low-cost, and this has triggered the competition between different providers of healthcare services. In order to maximize the efficiency of the services at low cost, hospitals, doctors, research clinics, private and public healthcare institutions are searching for alternatives [22] and CC technologies could be one of the top as if appropriately implemented, they will achieve the requirements of HIS. Hence, CC paves the way for healthcare opportunities towards enhancing services, enhancing operational facilities and sharing information with ease, while lowering costs [22]. CC in healthcare enables doctors to access patient's records whenever and wherever they need them, indicating that using CC in healthcare can be advantageous for patients at a global level [22]. The shift towards CC-based healthcare services in hospitals transforms the traditional concept and enhances it to be unbound by physical limitations of healthcare organizations, promoting the new era of self and domestic healthcare. This may be exemplified by the centricity practice, which is a cloud-based healthcare service provided by General Electric (GE) which provides Patient Self-Service Portal assisting the communication between patients and healthcare providers in a remote and secure manner [23]. Similarly, Practice Fusion was also brought forth by Dell, offering electronic healthcare records package for SMEs in the healthcare business [23].

Additionally, CC technology has incorporated applications to help healthcare professionals towards system usage – such use will benefit patients suffering from chronic conditions, who require constant monitoring and consultation from healthcare entities (e.g., patients living in rural areas). CC is also elastic in that it can expand and contract depending on the system use by the client and thus, it assists in resolving feasibility and scalability challenges [23].

Throughout the previous years, Jordanian hospitals have begun to adopt CC for IT services platform, but prior studies only focused on the critical factors affecting the decisions to adopt among users [24, 25], with only few carried out to shed

light on CC success within hospitals [26, 27]. Particularly, Garrison et al. [25] stressed on the critical role of the 3 IT capabilities, namely managerial, technical, and relational, towards CC success, albeit their study was limited to IT capabilities. Also, they did not apply their examination to the healthcare industry, an industry with its own specific characteristics. In another related study [27], the CC characteristics were integrated to the IS success model and trust to determine the critical success factors that influence private cloud computing success in Taiwanese hospitals.

3. Theoretical Model and Hypothesis

Prior researchers have included several variables to gauge user satisfaction with new technology (e.g., Cloud Computing). Following studies in literature, this study employs the IS success model as the theoretical basis and underpinning theory proposed by De Lone and Mc Lean [28]. IS researchers have verified the model [29, 30] and shed light on the electronic health record (HER) success in healthcare institutions [31], making it appropriate to shed light on the feasibility of cloud-based hospital IS in Jordan. According to the model, information quality, system quality and service quality are factors that have a positive effect on the user's intention and satisfaction of system use. Additionally, user's intention will contribute to user behavior and consequently influence his/her satisfaction and with better satisfaction level, use intention is enhanced, which represents a loop [32]. Lastly, IS success is proposed to lead to net benefits and enhanced continued intention towards IS usage [28] (see Figure 1). Based on the IS outsourcing point of view, critical factors have a hand in measuring IS success model with the use of trust [22], networking quality [29], and perceived risk [33]. More importantly, these variables are considered as the main cloud computing indicators, particularly in the healthcare institutions. Therefore, the study developed and proposed a model through the extension of De Lone and Mc Lean's IS success model [28] in order to achieve the study objectives. Figure 2 presents the proposed model with the variables.

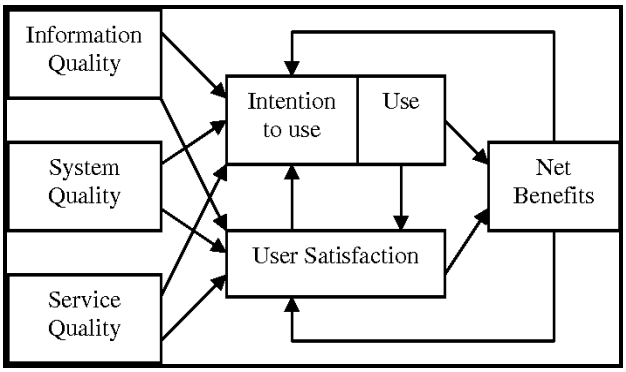

Figure 1: Updated Information Systems Success Model[28]

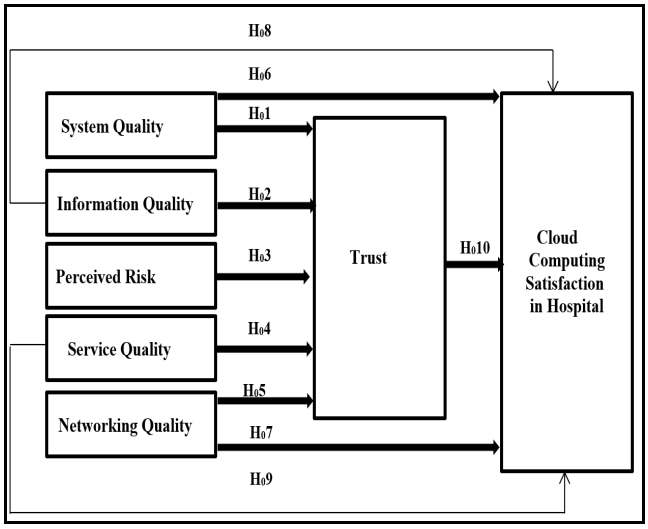

Figure 2: Proposed Model

On the basis of literature, this study tested ten null hypotheses regarding the factors examined as the critical CC satisfaction predictors in Jordanian hospitals, and they are as follows;

$H_0$1: System quality of cloud computing has no positive influence on hospital trust towards IS service providers.

$H_0$2: Information quality of cloud computing has no positive influence on hospital trust towards IS service providers.

$H_0$3: Perceived risk of cloud computing has no positive influence on hospital trust towards IS service providers.

$H_0$4: Service quality of cloud computing has no positive influence on hospital trust towards IS service providers.

$H_0$5: Networking quality of cloud computing has not positive influence on hospital trust towards IS service providers.

$H_0$6: System quality of cloud computing has not positive influence on hospital satisfaction.

$H_0$7: Information quality of cloud computing has not positive influence on hospital satisfaction.

$H_0$8: Service quality of cloud computing has no positive influence on hospital satisfaction.

$H_0$9: Networking quality of cloud computing has not positive influence on hospital satisfaction.

$H_0$10: Trust of cloud computing has no positive influence on hospital satisfaction.

4. Research Design and Method

This study adopted an e-mail questionnaire survey, within which the instruments were adopted from prior studies (see Table 1). The questionnaire was developed, and its reliability and validity were confirmed following specific steps, the first of which involved the translation of the survey from English to Arabic by specialists – thy translated the statements into Arabic and verified the meanings equivalency in both languages. This is followed by confirming the content validity of the items, which required the services of two IS experts and one from the hospital managerial level. They were requested to review the questionnaire survey and provide their feedback, based on which the content was modified. The study also conducted a pilot study involving 20 CIOs in the Jordanian

hospitals for validity and reliability establishment. The pilot study results necessitated changes to be made to the questionnaire items. Lastly, 56 items were included in the questionnaire survey for the measurement of the research model variables. The items were gauged along a 5-point Likert scale that ranged from 1 (strongly disagree) to 5 (strongly agree).

Table1: The study variables and Instruments

Variables	Item No.	Source
System quality	6	[34][27]
Information quality	8	[34][27]
Perceived risk	6	[35]
Service quality	22	[27]
Networking quality	6	[29]
Trust	4	[36]
Satisfaction	4	[29]

Data was collected from January 2021 to March 2021 from 106 CIOs working in Jordanian hospitals, from which valid questionnaires numbered 98 questionnaires (rate of response of 92.4%).

5. DATA ANALYSIS AND RESULTS

The study used SPSS statistical tool to provide an explanation of the demographic profile of the respondents on the basis of descriptive analysis, and to establish the instrument reliability using Cronbach's Alpha coefficient and Composite Reliability (CR). The study also adopted Structural Equation Modeling (SEM), using Partial Least Squares (PLS) to analyze data, validate the measurements of the model and confirm its structural components.

5.1 Respondents' Demographic Characteristics

As mentioned, there were 98 responses deemed usable, following the exclusion of incomplete responses. The frequencies of the respondents' age, gender, scientific qualification, job experience and hospital type are displayed in Table 2.

Table 2: Characteristics of Respondents

Characteristics	Frequency	Percent
Age		
18-30	11	11.22
31-40	55	56.12
41-50	17	17.35
Over 50	15	15.31
Gender		
Male	86	87.75
Female	12	12.25
Scientific Qualification		
Diploma or less	8	8.16
Bachelor	83	84.69
Master	6	6.12
Ph.D.	1	1.03
Job Experience		
1-5	3	3.06
6-10	14	14.29
11-20	76	77.55
Over 20	5	5.10
Hospitals		
Government	31	31.63
Military	15	15.31
Private	50	51.02
University	2	2.04

Based on the analyzed demographic data and personal information of respondents, majority of the respondents (98) were male, constituting 87.75% of the total respondents, while the remaining (12) were female, constituting 12.25%. With regards to the respondents' ages, majority of them fell in the category of 31 to 50 years of age (72%), and as for their scientific qualification, majority of them (83, constituting 84.69%) held bachelor's degrees. Additionally, majority of the respondents had extensive experience in the healthcare informatics field, with 83% of them holding more than 10 years of healthcare experience. Majority of them were also CIOs and directors of departments related with It. From the 98 hospitals examined, majority were private hospitals (50 hospitals, constituting 51.02%), followed by government hospitals (31 hospitals, constituting 31.63%), military hospitals (Jordanian Royal Medical Services) (15 hospitals, constituting 15.31%), and lastly, university hospitals (2 hospitals, constituting 2.04%), located in three different regions, and 12 Jordanian governorates, indicating the data set representativeness.

5.2 Measurement of Validity and Reliability

The study measurements were evaluated for their validity and reliability based on CR, AVE and Cronbach's alpha with the following established criteria; CR>.7, AVE>0.5, and Cronbach's Alpha >.7, with squared AVE values higher than the correlation coefficients to establish discriminant validity [27, 37]. Table 3 displays the acceptable indices.

Table 3: Validity and Reliability

Variables	CR	AVE	Factor loading	R^2	Cronbach's α
System quality	0.88	0.72	0.82-0.90	NA	0.87
Information quality	0.85	0.83	0.76-0.84	NA	0.85
Perceived risk	0.82	0.81	0.85-0.89	NA	0.82
Service quality	0.78	0.76	0.73-0.91	NA	0.79
Networking quality	0.88	0.82	0.84-0.90	NA	0.88
Trust	0.84	0.88	0.80-0.88	0.382	0.84
Satisfaction	0.89	0.85	0.90-0.93	0.773	0.88

As stated, discriminant validity was ensured through the squared AVE values, compared with the constructs correlations [38]. The above results showed that each of the construct's had acceptable discriminant validity and that data can be exposed to further analysis.

5.3 Hypothesis Testing

The proposed model was considered to have good fit to the observed data, and therefore, the next step involved testing the null hypotheses proposed by the research model. In this stage, the constructs hypothetical relations were tested using a standardized path of their relationships. Based on the results obtained from the PLS, all null hypotheses were rejected – these included the relationships of critical determinants of cloud satisfaction in hospitals, namely system quality, networking quality, information quality, service quality and trust, with R2 of 77.3%. Trust was found to mediate between perceived risk variables and satisfaction, indicating that the former directly affects trust, and indirectly affects satisfaction. On the whole, the proposed hypotheses were significant and had positive effects, which indicates that the proposed null hypotheses were all rejected. Table 4 tabulates the summarized results.

Table 4: Overall Hypothesis analysis

Hypotheses	Standardized coefficient (β)	SE (P)	Support
$H_0$1	0.532*	0.008	Not Support
$H_0$2	0.443*	0.006	Not Support
$H_0$3	0.462*	0.004	Not Support
$H_0$4	0.346*	0.023	Not Support
$H_0$5	0.478*	0.016	Not Support
$H_0$6	0.454*	0.009	Not Support
$H_0$7	0.351*	0.014	Not Support
$H_0$8	0.567*	0.000	Not Support
$H_0$9	0.498*	0.005	Not Support
$H_0$10	0.623*	0.000	Not Support

***P < 0.001**

According to the above table, system quality of CC significantly and positively affected trust towards IS service providers ($H_0$1,β= 0.532, p< 0.008). Along a similar line of results, information quality, perceived risk, service quality and networking quality of CC also had significant positive effects on trust towards CC service providers with the following results; ($H_0$2,β= 0.443, p< 0.006), ($H_0$3,β= 0.462, p< 0.004), ($H_0$4,β= 0.346, p< 0.023), and ($H_0$5,β= 0.478, p< 0.016) respectively. Moreover, system quality had a positive effect on hospital satisfaction ($H_0$6,β= 0.454, p< 0.009), information quality had a positive effect on hospital satisfaction ($H_0$7,β= 0.351, p< 0.014), service quality had a positive effect on hospital satisfaction ($H_0$8,β= 0.567, p< 0.000), and networking quality had a positive effect on hospital satisfaction ($H_0$9,β= 0.498, p< 0.005). Finally, trust of CC had a positive effect on hospital satisfaction ($H_0$10,β= 0.454, p< 0.000). With regards to the construct's variance on satisfaction of cloud computing, the overall explanatory power of the sequential dependent variable (CC satisfaction) was found to be 77.3%, indicating that the proposed model statistically and significantly explained CC satisfaction to this extent.

6. CONCLUSION

Although cloud computing provides several benefits for hospitals, like cost reduction of software, hardware, and data processing, tended network access and flexibility, its implementation in Jordanian hospitals is quite at a low level. Thus, the present study proposed a model extending the IS success model in order to determine the factors that influence hospitals towards adopting and being satisfaction with the cloud computing technology in Jordan. The model integrated some factors that were highlighted from the reviewed literature and other new factors that prior studies have not examined in terms of their impact on CC satisfaction. The study sample numbered 98 CIOs working in Jordanian hospitals and based on the analysis of their responses, information quality, service quality, perceived risk, system quality and trust are the major factors that influence satisfaction of CC technology. In sum, the proposed model is capable of explaining successful CC technology use and satisfaction in hospitals, and the findings are expected to provide a deeper insight into the success factors that bring about such success and satisfaction. The findings have implications towards hospitals, cloud providers and decision-makers when it comes to cloud computing technology implementation.

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