Affecting factors of cloud computing adoption in public hospitals affiliated with Zahedan University of Medical Sciences: A cross-sectional study in the Southeast of Iran

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Abstract

Objective: Health care organizations require cloud computing to remain efficient and cost-effective, and provide high-quality health care services. Adoption of this technology by users plays a critical role in the success of its application. This study aimed to determine factors affecting cloud computing adoption in public hospitals affiliated with Zahedan University of Medical Sciences.

Methods: A cross-sectional descriptive and analytic study was performed in 2017. The study population comprised information technology and hospital information system authorities and hospital information system users. The sample consisted of 573 participants. The data were collected using a questionnaire and analyzed with the Statistical Package for Social Sciences software using descriptive and analytical statistics.

Results: The mean score of environmental, human, organizational, technological, and intention dimensions of cloud computing adoption was 3.39 ± 0.81, 3.27 ± 0.63, 3.19 ± 0.71, 3 ± 0.43, and 3.55 ± 1.10, respectively. Furthermore, a significant positive relationship was found between intention of cloud computing adoption and environmental ($R = 0.521$, $p = 0.000$), organizational ($R = 0.426$, $p = 0.000$), human ($R = 0.492$, $p = 0.000$), and technological dimensions ($R = 0.157$, $p = 0.000$).

Conclusions: Benefits of cloud computing adoption, relative advantage, and competitive pressure were identified as the most influential factors in accepting cloud computing. Simplifying the users' understanding of this technology and its application, improving the staff's technical capabilities, promoting executive managers' understanding of the nature and functions of cloud computing, and fully supporting and increasing governmental mandates for adoption of new technologies are necessary for facilitating the adoption of cloud computing in given hospitals.

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Introduction

Iranian health care services are facing various challenges such as the burden of chronic diseases, shortage of health care professionals, and paucity of financial resources.[1] Continuing health transitions in developing countries, such as demographic and epidemiological changes, affect the quantity and quality of health care services in these countries.[2] Using health information technologies could improve the efficiency of these services and provide benefits for health care organizations.[3]

Many of these organizations have implemented a hospital information system (HIS) to decrease their costs and medical errors and improve the quality of care and access to resources.[4] Implementation of these systems may be associated with some difficulties like complexity, incompatibility, and inadequate information technology infrastructures.[5] Standalone HIS is an obstacle to the integration of health care processes and information sharing.[6,7] According to studies conducted in Iran, implementation of these systems is not completely successful[8] and is associated with problems like lack of strong information networks, erroneous data entry, technical issues in system development, lack of education, and lack of users' knowledge about the system and how to work with it.[3] Thus, health care providers are obliged to use innovative and cost-effective technologies to overcome such issues. Cloud computing technology has the potential to meet these problems because of its capabilities.

Cloud computing, as modern technology, could reduce the costs of data processing in the health industry by improving the validity, flexibility, accessibility, and operational power of the process. There is no unique definition of cloud computing.[9] However, cloud computing could be described as an exclusive technology that uses virtualization and network-based computing to provide services such as software, hardware, or platform through public, community, private, or hybrid cloud-based on the user's demands.[10] Reducing the costs of health care services through using new platforms to achieve electronic records and secure and share information in a real-time manner is an inevitable strategy of health care organizations.[11] Lack of resources and computing power in hospitals along with recent advances in health informatics has hindered data analysis.[12] Health care organizations generate large amounts of data in various formats (structured, semi-structured, and unstructured data) that should be available on-demand regardless of time and place. Processing and storing such data require highly skilled staff, large computational infrastructures, and high maintenance costs.[13–17] Cloud computing allows unlimited storage and updating of information technology infrastructures,[13–17] information exchange and sharing,[16,18,19] data mining,[20] and retrieving data after disasters[15] at lower costs because of its flexibility. Thus, the health care industry requires cloud computing technology to provide cost-effective, efficient, and high-quality services.[21–24]

Over the last decade, cloud computing has expanded to a large extent in the field of health information technology[25] and has facilitated cloud computing adoption in the health domain, especially in the adoption of electronic health records.[9,22,26] However, adopting this technology is influenced by various factors. Harfoush et al.[9] introduced human, technological, organizational, and environmental dimensions as factors affecting the adoption of cloud computing. In addition to the above dimensions, Lian et al.[27] and Yaghoubi et al.[28] introduced the human dimension, and Alharbi et al.[5] identified the business dimension as factors affecting cloud computing adoption.

The development of health care information systems in the future increasingly depends on cloud computing technology.[9,29] Previous studies have indicated the positive impact of this technology on the nature and structure of HIS.[22,27] Ratnam et al.[11] emphasized that cloud computing adoption would lead to increased efficiency, improved clinical services, and decreased costs.

Many studies have shown the benefits of cloud computing adoption and introduced different models of services rendered based on cloud technology in the health care domain.[30–34] However, there are administrative, technological, security, and legal challenges in the adoption of cloud computing and as a result, this technology has been adopted on a limited scale. The impact of factors affecting cloud computing adoption may vary in different health care organizations and countries.[35] Few studies have assessed the adoption of cloud computing services in hospitals in other countries.[9,36] Furthermore, it is critical to identify the determinants of adopting this technology from the users' perspectives.[37]

According to a review of the literature, very few Iranian studies have investigated the adoption of cloud computing and its determinants. This study was conducted to identify the determinants of cloud computing adoption in the public hospitals affiliated with Zahedan University of Medical Sciences from the users' perspective. Moreover, we tested one hypothesis as follows:

H1: There is a significant relationship between the intention of cloud computing adoption and the affecting factors of cloud computing adoption.

Material and methods

This descriptive-analytical cross-sectional study was conducted in 2017. The research population included 12 information technology and HIS authorities and 1435 HIS users (including 217 physicians, 1003 nursing users, 49 medical records users, 49 laboratory users, 98 radiology users, and 19 pharmacy users) working in five teaching hospitals of Ali-ibne-Abitaleb, Khatam-ol-Anbia, Alzahra, Baharan, and Buali hospitals affiliated with Zahedan University of Medical Sciences. Sampling was done only for nursing

users. According to the Cochran formula, 278 subjects were required, and stratified sampling was used to select samples in each hospital. The nurses of each hospital were then selected using a random number table. If selected samples declined to participate in the study, the next sample would be considered in the study.

A questionnaire was designed by authors based on previous studies[27,28,35,36,38] to collect the data. The authors obtained permission to distribute the questionnaires from the given hospitals' managers. The questionnaire was distributed among the participants and a 2-week interval was observed for the participants to complete the questionnaire. The anonymity and privacy of the participants were preserved and the collected data are stored securely.

Our study is based on the four-dimensional model (human, technology, organization, and environment) used by Lian et al.,[27] to which we added the intention to the adoption of cloud computing dimension. In addition to the demographic part (six questions), the questionnaire contained 45 questions and was divided into five dimensions, including technology ($n = 13$; variables: security, complexity, compatibility, and costs with two, five, three, and three questions, respectively), human ($n = 7$; variables: chief information officers (CIO) innovativeness and users' technical competence with four and three questions, respectively), organizational ($n = 18$; variables: relative value of cloud computing adoption, top management support, resource adequacy, and benefits of cloud computing adoption with four, four, five, and five questions, respectively), environmental ($n = 4$; variables: government policy and competitive pressure with two and two questions, respectively), and intention to adopt cloud computing ($n = 3$; questions). Each question was scored by the respondents for effect. The questions were measured on a 5-point Likert scale (from 1: strongly disagree to 5: strongly agree).

The questionnaire was validated by a panel of four health information management experts. The reliability of the questionnaire was examined using test–retest reliability (Cronbach's alpha = 0.89). The data were analyzed in terms of descriptive statistics (percentage, mean ± standard deviation) and analytic (Spearman and Pearson correlations) statistics using the Statistical Package for Social Sciences (SPSS) software.

The hypothesis was tested using the Pearson correlation test to determine the relationship between independent variables of technology, human, organizational and environmental, and the dependent variable of the intention of cloud computing adoption.

Results

Seven hundred questionnaires were distributed, of which only 596 were completed and returned (response rate = 85%). Twenty-three questionnaires were discarded, of

Table 1. Respondents' demographics.

Category	Subcategory	Total number	%
Gender	Male	190	33
	Female	383	67
Age	21–27	228	40
	28–34	172	30
	35–41	103	18
	42–48	51	9
	49–55	19	3
Job level	Physician	154	27
	Nursing	227	40
	Laboratory	92	16
	Radiology	34	6
	Pharmacy	12	2
	Information technology	8	1
	Medical records	46	8
Work experience	7 years and less	351	61
	8–14	130	23
	15–21	47	8
	22–28	38	7
	29–35	7	1
Education	Diploma	1	0[a]
	Associate's degree	9	2
	Bachelor's	387	68
	Master's	29	5
	Professional doctor	147	26

[a]The values of this item was 0.2% that was rounded.

which 14 were related to nursing users and nine belonged to the medical staff.

According to Table 1, most of the users were female (67%), about 40% of them were 21–27 years old, and the majority of them had <7 years of work experience (61%)

Table 2. The mean score and correlation of affecting factors of cloud computing from the viewpoints of HIS users.

Dimensions	Variables	Mean ± SD	Rank	1	2	3	4	5
1. Technology (3 ± 0.43)	Security	3.06 ± 0.67	10	1				
	Complexity	2.71 ± 0.68	12					
	Compatibility	3.17 ± 0.71	8					
	Cloud computing costs	3.08 ± 1.08	9					
2. Human (3.27 ± 0.63)	CIO innovativeness	3.34 ± 0.80	5	0.033	1			
	users' technical competence	3.20 ± 0.90	7					
3. Organizational (3.19 ± 0.71)	Relative advantage	3.56 ± 0.89	2	0.189*	0.495*	1		
	Top management support	2.69 ± 1.03	13					
	Resource adequacy	2.93 ± 0.90	11					
	Benefits of cloud computing adoption	3.57 ± 0.92	1					
4. Environmental (3.39 ± 0.81)	Government policy	3.24 ± 0.88	6	0.153*	0.383*	0.583*	1	
	Competitive pressure	3.54 ± 0.95	4					
5. Intention of cloud computing adoption (3.55 ± 1.10)	–	3.55 ± 1.10	3	0.157*	0.492*	0.426*	0.521*	1

HIS: hospital information system; CIO: chief information officers.
*p-value <0.01.

and a bachelor's degree (67%). In the users' population, nursing users comprised most of the respondents (63%).

Table 2 shows that the highest and lowest mean score of the factors affecting the adoption of cloud computing was related to the intention of cloud computing adoption (3.55 ± 1.10) and technology dimensions (3 ± 0.43), respectively. Moreover, the highest and lowest mean score of the variables affecting the adoption of cloud computing was related to benefits of cloud computing adoption (3.57 ± 0.92) and top management support (2.69 ± 1.03), respectively. In addition, a significant positive relationship was found between intention of cloud computing adoption and environmental dimension ($R = 0.521$, $p = 0.000$), and between organizational and environmental dimensions ($R = 0.583$, $p = 0.000$).

According to Table 3, there was a very strong positive correlation between benefits of cloud computing adoption and competitive pressure ($R = 0.816$, $p = 0.000$), benefits of cloud computing and relative advantages of cloud computing adoption ($R = 0.645$, $p = 0.000$), and resource adequacy and top management support ($R = 0.603$, $p = 0.000$). Moreover, a strong positive correlation was observed between competitive pressure and government policy ($R = 0.582$, $p = 0.000$),

users' technical competence and resource adequacy ($R = 0.538$, $p = 0.000$), and intention to adopt cloud computing and competitive pressure ($R = 0.508$, $p = 0.000$).

Discussion and conclusion

The mean score of the technology dimension from the user's perspective was 3 ± 0.43, indicating that technology has a marked effect on the adoption of cloud computing. As for the dimension of technology, the highest and the lowest mean score was related to compatibility (3.17 ± 0.71) and complexity (2.71 ± 0.68) of cloud computing technology, respectively. Lian et al.[27] reported a mean score of 4.16 ± 0.62, Alharbi et al.[5] calculated a mean score of 3.62 ± 1.03, and Oliveira et al.[35] reported a mean score of 3.01 ± 0.87 for the technology dimension. Kuo et al.[22] introduced this dimension as an important factor in the adoption of cloud computing in the health care industry. Moreover, Chang et al.[39] reported that the technology dimension is an effective factor in making decisions to implement cloud computing. Zeinali[40] introduced security, information protection, and data integration, and portability as the most important challenges in

Table 3. The mean score and correlation of variables of affecting factors on cloud computing adoption.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Security	1												
2. Complexity	0.08*	1											
3. Compatibility	0.21**	−0.11**	1										
4. Cloud computing costs	0.07	0.02	−0.07	1									
5. CIO innovativeness	0.20**	−0.15**	0.20**	0.02	1								
6. Users' technical competence	0.18**	−0.32**	0.19**	−0.07	0.10*	1							
7. Relative advantage	0.21**	−0.14**	0.28**	0.08*	0.37**	0.20**	1						
8. Top management support	0.12**	0.08*	0.31**	−0.14**	0.12**	0.25**	0.31**	1					
9. Resource adequacy	0.13**	−0.07	0.37**	−0.15**	0.15**	0.53**	0.30**	0.60**	1				
10. Benefits of cloud computing	0.28**	−0.19**	0.34**	0.04	0.31**	0.27**	0.64**	0.29**	0.43**	1			
11. Government policy	0.14**	−0.19**	0.32**	−0.09*	0.25**	0.27**	0.27**	0.16**	0.35**	0.49**	1		
12. Competitive pressure	0.30**	−0.15**	0.33**	0.08*	0.35**	0.13**	0.59**	0.17**	0.31**	0.81**	0.58**	1	
13. Intention of cloud computing adoption	0.22**	−0.23**	0.28**	0.09*	0.59**	0.16**	0.53**	0.08*	0.19**	0.50**	0.41**	0.50**	1

CIO: chief information officers.
*p-value <0.05; **p-value <0.01.

the adoption of cloud computing. Yaghoubi et al.[28] reported that the technology dimension ranks first among determinants of adoption of cloud computing in electronic health (e-health). The findings of this study are consistent with the results of some studies[5,35] but relatively inconsistent with the results of some other studies.[27] This contradiction could be due to differences in the study population. Thus, facilitation of the understanding and use of cloud computing by users could improve adoption of this technology in the given hospitals.

The mean score of the human dimension was 3.25 ± 0.59 from the user's perspective, indicating that the human factor has a great effect on the adoption of cloud computing. Regarding human variables, the highest and the lowest mean score was related to CIOs innovativeness (3.34 ± 0.80) and users' technical competence (3.20 ± 0.90), respectively. Lian et al.[27] reported a mean score of 4.02 ± 0.54 and Alharbi et al.[5] reported a mean score of 3.36 ± 1.12 for the human factor. Lin et al.[41] indicated that staff's competence was an important variable of the human dimension affecting the adoption of cloud

computing. Yaghoubi et al.[28] reported the human factor has the second rank among factors affecting the adoption of cloud computing in electronic health. Yunesian et al.[42] indicated that using skilled staff and experienced experts facilitated the implementation of cloud computing in hospitals. According to Sepehr et al.,[43] librarians had a good competence in the implementation of cloud computing in Tehran Medical Sciences Universities' libraries. The findings of this study are consistent with the results of some studies[5] but relatively inconsistent with the results of some other studies.[27] This contradiction could be due to differences in the research population. Thus, enhancement of the staff's technical capability could affect adoption of innovative technologies such as cloud computing in hospitals.

The mean score of the organizational dimension was 3.19 ± 0.71 from the users' perspective, indicating that the organizational factor has a strong effect on the adoption of cloud computing. Regarding this dimension, the highest and the lowest mean score was related to potential benefits of employing cloud technology (3.57 ± 0.92) and

top management support from this technology (2.69 ± 1.03), respectively. Lian et al.,[27] Alharbi et al.,[5] and Oliveira et al.[35] reported a mean score of 3.84 ± 0.75, 3.48 ± 1.15, and 3.58 ± 1.07 for the organizational dimension, respectively. Yaghoubi et al.[28] reported the organizational factor ranks third among factors affecting the adoption of cloud computing in electronic health. This finding is in line with the results of earlier studies. However, the promotion of executive managers' understanding of the nature and functions of cloud computing and fully supporting its development could facilitate the adoption of this technology in hospitals.

The mean score of the environmental dimension was 3.39 ± 0.81 from the users' perspective, indicating that the environmental factor has a very strong effect on the adoption of cloud computing. Regarding this dimension, the highest and the lowest mean score was related to competition between hospitals for cloud technology (3.54 ± 0.95) and government policy regarding the development of new technologies (3.24 ± 0.88), respectively. Lian et al.,[27] Alharbi et al.,[5] and Oliveira et al.[35] reported a mean score of 3.75 ± 0.72, 3.43 ± 1.01, and 2.44 ± 0.85 for this dimension, respectively. Yaghoubi et al.[28] reported that the organizational factor has the fourth rank among factors affecting the adoption of cloud computing in electronic health. The finding of this study is in line with the results of some studies[5,27] but relatively inconsistent with the results of some other studies.[35] This contradiction could be due to differences in the research population. Nonetheless, increasing governmental pressures for the adoption of new technologies could accelerate the adoption of cloud computing.

The mean score of intention to adopt cloud computing was 3.55 ± 1.10 from the users' perspective, indicating that users have great interest in the adoption of cloud technology. Oliveira et al.[35] reported a mean score of 2.40 ± 1.61 for this dimension. This finding is incompatible with the results of one study. This contradiction could be due to differences in attitude, knowledge, and background of the research population about cloud computing.

The tested hypothesis showed a strong significant positive relationship between intention to adopt cloud computing and the environmental dimension ($R = 0.521$, p-value $= 0.000$). Furthermore, there was a significant positive relationship between intention to adopt cloud computing and the organizational ($R = 0.426$, p-value $= 0.000$) and human dimension ($R = 0.492$, p-value $= 0.000$). In addition, there was a positive weak relationship between intention to adopt cloud computing and the technology dimension ($R = 0.157$, p-value $= 0.000$). Harfoushi et al.[9] reported a significant positive relationship between the technology dimension and adoption of cloud computing ($R = 0.431$, p-value $= 0.000$), and Ratnam and Dominic[11] showed a very strong positive correlation between cloud adoption and information technology (IT)

capability in health care services ($R = 0.802$, $p = 0.000$) and IT resources ($R = 0.689$, $p = 0.000$).

Conclusions

In general, the environmental, human, organizational, and technological dimensions were identified as the most important determinants of cloud computing adoption from the users' perspective. However, benefits of cloud computing adoption, relative advantage, and competitive pressure were identified as the most influential factors in accepting cloud computing. Thus, simplifying the understanding and use of this technology by users, improving the staff's technical capability, promoting the executive managers' understanding of the nature and functions of cloud computing to support top managers from this technology and the alignment of government policy on the implementation of cloud computing technology in health care institutions are necessary for facilitating the adoption of cloud computing in the given hospitals.

Summary table

Summary of previous studies

- HISs implemented in Iran has not been completely successful.
- Because of the flexibility and capabilities of the cloud computing method, the use of this technology in the health care industry of Iran, especially in hospitals, is unavoidable.
- Users play a decisive role in adopting new technologies in the organization.
- Determinants of cloud computing adoption cloud vary in different health care organizations and countries.

Summary of this study

- Very few studies have addressed the adoption of cloud computing in the health sector in Iran.
- No studies have assessed the factors affecting the adoption of cloud computing from the users' perspective in Iranian hospitals.
- Environmental, human, organizational, and technological dimensions in addition to intention to adopt cloud computing are determinants of adoption of cloud computing in hospitals.

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