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Original Article

Potential Challenges of RFID Implementation: A Survey in Teaching Hospitals

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Abstract

Introduction: Radio-Frequency Identification (RFID) can increase the quality of healthcare and improve patient safety by collecting information, automatically identifying patients, tracking patient movements and hospital equipment. However, successful implementation and adoption of this technology face several barriers. The objective of this study was to identify and prioritize the potential challenges of implementing RFID in hospitals.

Methods: This study was conducted on all information technology administrators and managers of educational hospitals in Kerman (n=43). Data were collected through a valid and reliable (α=0.94) questionnaire. The questionnaire consisted of two sections with 33 questions (4 questions for demographic information and 29 questions for implementation barriers). T-test and one-way ANOVA were used to examine the relationship between the barriers and demographic information.

Results: Financial (3.67), managerial-specialized (3.40) and attitudinal-behavioral (3.36) barriers had the highest means among the RFID implementation barriers, respectively. Age, gender, work experience, and organizational position had no effect on the prioritization of barriers (P<0.05).

Conclusion: Failure to finance RFID implementation project, spending a lot of time and money to train RFID users, and unfamiliarity of users with RFID created the most problems in implementing this technology, respectively. Therefore, making short and long-term policies to address these barriers are recommended. Hospital managers can overcome implementation barriers by making decisions based on a detailed and transparent analysis of return on investment, allocating funds to implementation projects, and careful planning for user training to improve their awareness and technical knowledge.

Keywords: Information technology, Radio frequency identification device, Patient identification systems.

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Introduction

With the growth of patient admissions and the complexity of health care processes and services, hospitals have faced numerous problems concerning automatic identification of patients, real-time access to patient statistics in hospital wards, tracking of patients, follow-up of medications, hospital equipment and property (1-3). To this end, the use of information technology in hospitals and health care organizations helps to overcome many of these problems (1-3). One of the helpful and effective technologies in this regard is Radio-Frequency Identification (RFID) (1-4).

FRID identifies and collects information about objects or individuals on a wireless network through the tags attached to them (1-5). This feature has enabled this technology to simultaneously perform information management, process automation, authentication and tracking (1-5). In other words, because of its ability to collect data, RFID can offer many benefits, such as standardization, facilitating workflow, and improving the quality of documentation for hospital management (1-5). RFID makes it possible for healthcare providers to quickly access patient identification and medical information by reading information from each patient's unique tag. Better management of stocks and tracking of laboratory and blood samples of patients and medication tracking are other benefits of using RFID in hospitals (5-8). According to Statista, by 2023, RFID will be used in healthcare organizations for various purposes including stocks management (32%),

patient tracking and monitoring (28%), medication identification and control (19%), access control (15%) and other purposes (6%) (9).

Despite the many benefits of RFID, implementation and use of this technology in hospitals and healthcare organizations have encountered barriers and constraints such as lack of technical infrastructure, inappropriate software and hardware, problems in designing, customizing and integrating this technology with other information systems (4, 5, 7). In addition, insufficient advertisement about the capabilities of RFID, lack of manager's knowledge, high cost of equipment, security, privacy and confidentiality concerns are other barriers to the implementation of RFID (4, 5, 7). Some of these barriers are a big challenge and need substantial time and cost to be resolved, while others can be prevented through proper planning. Therefore, prioritization of these barriers and challenges can help effectively utilize limited resources and support the decisions of health policymakers.

Many studies have described the benefits and capabilities of RFID in healthcare organizations (5, 10, 11) and provided a conceptual model for assessing the quality of RFID services (12, 13). On the other hand, other studies have addressed RFID barriers and factors influencing the adoption of this technology (4, 5, 7, 11, 13-22). According to a systematic review by Handayani et al. (23), studying users' viewpoints and acceptance rates is one of the important factors in identifying and prioritizing the challenges of implementing information systems in hospitals. User acceptance indicates willingness to use information technology to perform tasks (23, 24). Since user resistance impede successful implementation of new technologies in an organization, it is important to examine the viewpoints of all groups of key users before implementation (23, 24). Health information systems (HIS) and communication technologies must be designed to meet the purposes of user groups through an understanding of human behavior and values (23). Additionally, discovering what motivates people to use new systems and understanding the source of resistance toward using new systems is important to hospital managers, system designers, and developers as it can help to increase the success of projects (24). The success of Health Information Technology (HIT) depends a great deal on the individual-level responses of end users; these responses include acceptance/rejection of IT and how (or even whether) use IT (25-27). In hospitals, IT administrators and hospital managers play an important role in the successful implementation of RFID. Therefore, the objective of this study was to identify potential challenges of RFID implementation from the viewpoints of IT administrators and hospital managers. The results of this study can be used to overcome the barriers to successful implementation of RFID in hospitals and other healthcare organizations.

Materials and Methods

This descriptive-analytic study was conducted in educational hospitals of Kerman University of Medical Sciences in 2019. Kerman University of Medical Sciences is one of the largest rank 1 universities located in Kerman province in the southeast of Iran.

Participants

We included hospitals with different specializations. For example, the following four general hospitals are mainly known for one of their specialties: Bahonar hospitals is known because of its trauma department, Shafa because of its cardiovascular department, Shahid Beheshti because of its mental health department, and Afzalipour because of its internal medicine department. RFID systems were not already deployed in these hospitals. In order to identify potential challenges of RFID implementation, sampling was not performed and all IT administrators and hospital managers (chief executive officers, nursing managers, and financial managers) employing in these hospitals were selected (n=43). Therefore, exclusion and inclusion criteria were not defined for selecting participants.

Data Collection Tool

Data were collected using a questionnaire developed by researchers based on the previous (4, 5, 7, 11, 13-22) and the opinions of IT professionals. The face and content validity of the questionnaire were confirmed by three medical informatics specialists. Cronbach's alpha coefficient was used to examine the reliability of this questionnaire (α=0.94). The questionnaire consisted of two parts (33 questions). The first part of the questionnaire contained four questions to collect demographic information (gender, age, work experience, job position) of the participants. In the second part, there were 6 groups of questions related to potential barriers to implementation, of which eight questions were designed for technical and technological barriers, four for organizational barriers, five for financial barriers, two for security barriers, four for managerial-specialized barriers, and six for attitudinal-behavioral barriers. These questions were answered using a five-point Likert scale ranging from strongly disagree to strongly agree.

Data Analysis

Data were analyzed by SPSS version 24. Responses to each item were scored from 1 (strongly disagree) to 5 (strongly agree). The mean and standard deviation of the scores assigned by the participants to each question were calculated. Then, to calculate the total score of each barrier, the scores given to the questions related to that barrier were summed. Finally, the mean score assigned to the participant opinions was calculated by dividing the total score of each barrier by the number of questions related to that barrier. One-way ANOVA and t-tests were used to examine the relationship between the barriers to implementation of RFID and the demographic information of the participants.

Results

The demographic information of the participants is shown in Table 1. Most study participants were male (67%), aged between 30 and 39 (40%), and had a work experience of more than 15 years (47%).

Based on the findings, the highest mean of the barriers to RFID implementation was related to financial barriers (3.67±0.87) and the lowest mean was related to security barriers (3.13±1.08) (Table 2).

The details of the RFID implementation barriers are presented in Table 3. The mean of items related to all barriers ranged between 2.81 and 3.89. "lack of communication and wireless infrastructure" with a mean of 3.65±1.14 was identified as the most effective factor among technical-technological barriers. "impossibility to test the system" with a mean of 2.94±1.11 was considered as the least important factor among technical-technological barriers. The mean of organizational barriers was in the range of 3.07 to 3.47, and the mean of financial barriers in the range of 3.52 to 3.89 (Table 3).

Among security barriers, "concern about information security and confidentiality" had the highest mean (3.21±1.25). The mean of managerial-specialized barriers was within the range of 3.28 and 3.52 (Table 3). In this study, "low level of technical knowledge" (3.71±0.83) was identified as the most important factor among attitudinal-behavioral barriers.

The analysis of the relationship between barriers to RFID implementation is shown in Table 4. Technical-technological and security barriers were significantly associated with other barriers to RFID implementation (P<0.0001).

Analysis of the data showed that there was no significant relationship between any of the technical-technological, organizational, financial, managerial-specialized, security, and attitudinal-behavioral barriers and the demographic information of the participants (P<0.05). This means that age, gender, work experience, and organizational position did not influence the choice of barriers to RFID implementation.

Table 1: Demographic information of participants

Demographic information	Frequency (Percent)	
	Hospital managers (n=27)	IT administrators (n=16)
Gender		
Male	20 (72)	12 (69)
Female	7 (28)	4 (31)
Age		
<30 years	1(4)	7(46)
30-39 years	10(36)	9(54)
40-49 years	10(36)	0(0)
50-59 years	6(24)	0(0)
Work experience		
<1 year	0(0)	4 (23.1)
1<5 years	0(0)	0(0)
5-10 years	6(20)	11(69.2)
11-15 years	2(8)	0(0)
>15 years	19(72)	1(7.7)

Table 2: The mean and standard deviation of the scores assigned to challenges of Radio-Frequency Identification (RFID) implementation

Barriers	Total scores	Mean (S.D)
Technical-technological	26.76	3.35(0.81)
Organizational	12.97	3.24(0.88)
Financial	18.34	3.67(0.87)
Security	6.26	3.13(1.08)
Managerial-specialized	13.61	3.40(1.08)
Attitudinal-behavioral	20.13	3.36(0.76)

Table 3: The means of each Radio-Frequency Identification (RFID) implementation barrier

Barriers	Barrier items	Mean (SD)
Technical-technological	Lack of communication and wireless infrastructure	3.65 (1.14)
	Potential interference with hospital equipment	3.05 (1.06)
	Lack of national standards	3.44 (1.0)
	Impossibility to test the system	2.94 (1.11)
	Lack of regional standards	3.31 (1.16)
	Lack of standard hardware and software	3.55 (1.08)
	Difficulty of integrating RFID with existing information systems	3.39 (1.07)
	Lack of non-ICT infrastructure	3.39 (0.91)
Organizational	Physical constraints of buildings	3.07 (1.17)
	Mismatch of the hospital building	3.23 (1.12)
	Need for management change in the organization	3.18 (1.15)
	Incompatibility of RFID with the complexity of hospital organization	3.47 (1.05)
Financial	Difficulty of analyzing the cost-effectiveness of RFID implementation projects	3.63 (0.94)
	Lack of RFID cost determination	3.52 (1.10)
	Failure to finance RFID implementation project	3.89 (1.06)
	Difficult calculation of return on investment	3.68 (1.09)
	High cost of equipment maintenance	3.60 (1.07)
Security	Legal barriers	3.05 (1.03)
	Concern about information security and confidentiality	3.21 (1.25)
Managerial-specialized	Spending a lot of time and money to train RFID users	3.52 (1.05)
	Lack of support from senior managers and decision-makers	3.28 (1.41)
	Lack of support from government and funding agencies due to the delay in RFID productivity	3.47 (1.20)
	Lack of experts and an executive team to implement RFID	3.31 (1.39)
Attitudinal-behavioral	Unfamiliarity of users with RFID and lack of technical knowledge	3.57 (1.28)
	Resistance of users to change traditional and manual processes and incompatibility with RFID	3.47 (1.03)
	Low technical knowledge	3.71 (0.83)
	Traditionally preventing the contribution of users in the implementation and their distrust in using RFID	3.50 (0.92)
	Patient resistance to using RFID bracelets	2.81 (1.22)
	Cultural constraints of society	3.05 (1.13)

Table 4: The relationship between Radio-Frequency Identification (RFID) implementation barriers with each other

Barriers		Mean difference	P value
Technical-technological	Organizational	13.78	<0.0001
	Financial	8.42	<0.0001
	Security	20.50	<0.0001
	Managerial-specialized	13.15	<0.0001
	Attitudinal-behavioral	6.63	<0.0001
Organizational	Financial	-5.36	<0.0001
	Security	6.71	<0.0001
	Managerial-specialized	-0.63	0.98
	Attitudinal-behavioral	-7.15	<0.0001
Financial	Security	12.07	<0.0001
	Managerial-specialized	4.73	<0.0001
	Attitudinal-behavioral	-1.78	0.48
Security	Managerial-specialized	-7.34	<0.0001
	Attitudinal-behavioral	-13.86	<0.0001
Managerial-specialized	Attitudinal-behavioral	6.63	<0.0001

Discussion

Main Findings

This study showed that, from the viewpoint of IT administrators and hospital managers, the financial, managerial-specialized and attitudinal-behavioral barriers were the most important barriers to RFID implementation, respectively. However, IT administrators and managers agreed on the priority of RFID implementation barriers and rated all barriers as above the average.

Financial Barriers

In this study, financial barriers were identified as the most important challenge among RFID implementation barriers. Consistent with this result, a study conducted by Reyes et al. (16) in the United States showed that financial barriers had been identified as the most significant challenge of implementing RFID based on the viewpoint of senior managers in hospitals, such as the vice president, chief executive officer, financial manager, and information manager. In the study of Reyes et al. (16) 44 out of the 88 participants were employed in hospitals without RFID implementation and only 13 participants in RFID implemented hospital. In the present study, all 43 participants were employed in hospitals without RFID implementation. Reyes et al. (16) showed that the mean of RFID implementation barriers including financial barriers is higher in hospitals that did not implement RFID, compared to other hospitals (hospitals that are planning to implement RFID in the future or are currently using it). Therefore, based on the results of the present study and the study conducted by Reyes et al. (16), it can be concluded that according to the managers of hospitals without RFID implementation, financial barriers are the biggest potential challenges. However, these barriers do not pose a major challenge in hospitals using RFID since they have realized the benefits of RFID implementation, including improved patient care, productivity, security, management assistance, and communication. Conversely, it also was shown that in hospitals where RFID was fully implemented (17) or piloted (14, 15), financial barriers have been identified as one of the most significant actual challenges of RFID implementation. In this regard, Lai et al. (17) studied the viewpoints of 37 senior managers in hospitals in which RFID was fully implemented in Taiwan. This study showed that the high cost of implementation was the most important factor in rejection of RFID by these participants. Kuo et al. (14) collected the viewpoints of 10 IT administrators and managers working in hospitals using RFID in Taiwan. These participants believed that the high cost of RFID implementation and intangibility of return on investment (ROI) in real environment are the most important challenges. In study by Vanany et al. (15), managers of hospitals using RFID identified the lack of funding and high cost of RFID as the second challenge of implementing this technology. Many review studies (5, 10, 19) identified the high cost of the system and low rate of ROI as the biggest challenge of implementing RFID. In addition to the high cost of RFID tags, other requirements such as infrastructures, middleware, and printers can also impose high costs on healthcare organizations (7). According to a study by Okoniewska et al. (20), from 2018 onwards, the cost of implementing RFID in healthcare organizations could be more than $ 2 billion a year. Based on the results of the present study, lack of funding for RFID implementation project, immeasurability of ROI, difficulty in analyzing the cost-effectiveness of RFID projects, high cost of equipment maintenance, and failure to determine the cost of RFID system are important barriers to successful implementation. These barriers have been reported by other studies, in both environments with and without RFID implementation. These barriers have prevented hospitals and other healthcare organizations to take advantage of RFID as this technology advances. Therefore, health policymakers can overcome the financial barriers of RFID implementation with long-term planning and proper budgeting.

Managerial-specialized Barriers

The second group of barriers to implementation of RFID identified in this study was the managerial-specialized barriers. Consistent with this result, previous studies Ebrahimi et al. (18), and Yao et al. (19) also identified managerial barriers as one of the factors influencing RFID implementation. Specifically, based on the results of the present study the following factors are among the most important RFID implementation barriers; excessive cost and time required to train the users on how to work with this technology, lack of government support and funding agencies, and lack of experts and executive team to implement this technology.

Attitudinal-behavioral Barriers

Based on the perspective of IT administrators and managers in this study, attitudinal-behavioral barriers were the third group of RFID implementation challenges. Congruent with this result, in the study of van der Togt et al. (12), and the study of Ebrahimi

et al. (18), user attitudinal and behavioral constraints were identified by managers as one of the most important challenges in hospitals without RFID. Our study specifically showed that unfamiliarity of users with RFID and lack of technical knowledge, resistance to change from traditional system, incompatibility of current processes with RFID, refusing participation of users in the implementation project and patient resistance to use this technology prohibit the successful implementation of RFID. According to the study by Berkowitz et al. (21), user (healthcare providers and patients) education is one of the factors affecting the utilization of information technology. Almalki et al. (22) also showed, that lack of educational materials to train users and the lack of IT professionals can lead to the failure of information systems implementation. Hence, providing training programs to enhance the knowledge of users and patients concerning RFID can help to overcome many of the attitudinal-behavioral barriers.

Technical-technological Barriers

In this study, technical-technological barriers were prioritized as the fourth group of barrier to RFID implementation. More precisely, lack of telecommunication and wireless infrastructure, inaccessibility of standard hardware and software, lack of national standards, incompatibility of RFID with existing information systems, and absence of non-ICT infrastructures were among the most important technical-technological barriers identified in this study. In line with the results of this study, in a number of previous studies (4, 10, 16), technical and technological barriers were identified as the most important barriers to the implementation of this technology. According to Coustasse et al. (4), lack of standard hardware and software is one of technical barriers to RFID implementation. Paaske et al. (5) reported that system errors, failure to scan RFID tags, interference with other medical equipment, and incompatibility with other health information technologies, are among the technical barriers of adopting RFID. In the study of Ahmadian et al. (28), hardware factors were the most important challenge in implementing hospital information systems. In their study, "lack of appropriate hardware and robust data networks" received a higher attention compared to other technical and hardware-related challenges of implementing hospital information systems. The widespread growth of health information technology has made the interoperability of systems among health care organizations very difficult. Therefore, providing standard hardware and software infrastructures and integrating new technologies with other information systems can lead to successful implementation and use of RFID in hospitals and other healthcare organizations.

Organizational Barriers

In our study, organizational barriers were identified as the fifth group of barriers to implementation of RFID. This part of the results confirmed the results of similar studies conducted by Yao et al. (10), and Ebrahimi et al. (18).

Security Barriers

In the current study, security barriers were identified as the last group of constraints. Azevedo et al. (11), and Winston et al. (13), likewise showed that security barriers and incompliance with privacy and confidentiality principles impact the implementation of RFID. Based on the results of the present study and previous studies, legal, security and confidentiality constraints are among the known barriers influencing the implementation of RFID. In this regard, several studies (29, 30) have focused on the importance of information security and privacy in health care information systems. Maintaining the confidentiality and security of patient information when sharing among different stakeholders is one of the important issues in the successful implementation of information technology in healthcare systems.

Strengths of Study

In present study, financial, managerial-specialized, and attitudinal-behavioral barriers are the most important potential challenges of implementing RFID in hospitals and other healthcare organizations. Various studies used interviews or questionnaires to examine the managers' viewpoints on the barriers to implementation of RFID and the factors influencing its adoption. In most of these studies, RFID was implemented either as a pilot or completely. However, the present study examined the viewpoints of hospital IT administrators and managers who play the biggest role in implementing RFID in hospitals that do not have this technology in place. Hospital managers play an important role in decision making, planning, funding and moving toward new technologies and in leading organizations and personnel to use these technologies. IT administrators, in addition to helping managers to make decisions, have the primary responsibility of implementing new technologies and training staff. Awareness of IT administrators about new technologies enables them to better understand the barriers and present these

barriers to managers and policymakers in a simpler way. As a result, identifying and prioritizing the barriers to RFID implementation from the viewpoint of IT administrators and managers can result in the successful implementation of this technology in the future.

Limitations

This study had three limitations. First, we first determined and categorized the barriers to RFID implementation, then asked the participants to prioritize each barrier. Hence, we may have missed some of the barriers. However, based on the results of previous studies, it seems that the most significant challenges of RFID implementation have been addressed in this study. Second, this study was conducted solely on the IT administrators and managers of teaching hospitals of a medical university. Therefore, the generalization of the results to a larger environment should be done with caution. Future studies could address the barriers to implementing this technology at a broader setting to provide a more comprehensive view of the issue. Third, although the barriers to RFID implementation in this study were identified based on the subjective opinion of the participants, we gathered the viewpoints of those who had the most important role in deciding to implement RFID. The challenges identified in this study were also identified by other studies conducted in the real environment of using RFID. Nevertheless, the finding uncovered various challenges in implementing RFID for policymakers and researchers. Health authorities and policymakers can plan to resolve each of these barriers by allocating the budget and time required to address each barrier. The reason that clinical staff (physicians and nurses) were not invited to participate in this study was that these individuals do not play a major role in the decision making about and implementation of health information systems.

Conclusion

Financial, managerial-specialized and attitudinal-behavioral barriers were the most important barriers to implementing RFID. Among these three barriers, failure to finance RFID implementation project, spending a lot of time and money to train RFID users, and unfamiliarity of users with RFID created the most problems in implementing this technology, respectively. In order to address these problems, raising the awareness of all health care practitioners by effective training methods seems necessary. Users' low level of technical knowledge and awareness can be the result of refusing to hold these training sessions to save money and time. This subjective opinion that providing training to users is costly and time-consuming could result from lack of funding for RFID implementation projects and the difficulty in calculating the rate of return on investment (ROI). As the present study showed, there is a significant relationship between financial and managerial-specialized barriers. Therefore, making short and long-term policies to address these barriers are recommended. Hospital managers can overcome implementation barriers by making decisions based on a detailed and transparent analysis of the ROI, allocating funds to implementation projects, and careful planning for user training to improve their awareness and technical knowledge.

Ethical Approval

This research was approved by the Ethics Committee of Kerman University of Medical Sciences (IR.KMU.REC.1397.556).

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References

1. Tu YJ, Chi H, Zhou W, Kapoor G, Eryarsoy E, Piramuthu S. Critical Evaluation of RFID Applications in Healthcare. *International Conference on Future Network Systems and Security*. 2019:240-8. doi: 10.1007/978-3-030-34353-8_18.
2. Abugabah A. Integrating RFID with healthcare information systems: toward smart hospitals. *Asian Journal of Information Technology*. 2017;16(9):734.
3. Haddara M, Staaby A. RFID Applications and Adoptions in Healthcare: A Review on Patient Safety. *Procedia Comput Sci*. 2018;138:80-8. doi: 10.1016/j.procs.2018.10.012.
4. Coustasse A, Cunningham B, Deslich S, Willson E, Meadows P. Benefits and Barriers of Implementation and Utilization of Radio-

Frequency Identification (RFID) Systems in Transfusion Medicine. *Perspect Health Inf Manag*. 2015;12:1d.
5. Paaske S, Bauer A, Moser T, Seckman C. The benefits and barriers to RFID technology in healthcare. *On-Line Journal of Nursing Informatics*. 2017;21(2).
6. Yazici HJ. An exploratory analysis of hospital perspectives on real time information requirements and perceived benefits of RFID technology for future adoption. *International Journal of Information Management*. 2014;34(5):603-21. doi: 10.1016/j.ijinfomgt.2014.04.010.
7. Thapa RR, Bhuiyan M, Krishna A, Prasad P. Application of RFID technology to reduce overcrowding in hospital emergency departments. Advances in Information Systems Development: Springer; 2018. p. 17-32. doi: 10.1007/978-3-319-74817-7_2.
8. Cao Q, Jones DR, Sheng H. Contained nomadic information environments: Technology, organization, and environment influences on adoption of hospital RFID patient tracking. *Information & management*. 2014;51(2):225-39. doi: 10.1016/j.im.2013.11.007.
9. Statista [Internet]. Global healthcare RFID market share by application in 2016 and a forecast for 2021. [Accessed 14 July 2019]. Available from https://www.statista.com/statistics/805245/rfid-healthcare-market-by-application-worldwide.
10. Yao W, Chu CH, Li Z. The adoption and implementation of RFID technologies in healthcare: a literature review. *J Med Syst*. 2012;36(6):3507-25. doi: 10.1007/s10916-011-9789-8.
11. Azevedo SG, Ferreira JJ. Radio frequency identification: a case study of healthcare organisations. *International Journal of Security and Networks*. 2010;5(2-3):147-55. doi: 10.1504/IJSN.2010.032213.
12. van der Togt R, Bakker PJ, Jaspers MW. A framework for performance and data quality assessment of Radio Frequency IDentification (RFID) systems in health care settings. *J Biomed Inform*. 2011;44(2):372-83. doi: 10.1016/j.jbi.2010.12.004.
13. Winston TG, Paul S, Iyer L, editors. A study of privacy and security concerns on doctors' and nurses' behavioral intentions to use RFID in hospitals. 2016 Jan 5-8. 2016 49th Hawaii International Conference on System Sciences (HICSS); 2016. doi: 10.1109/HICSS.2016.392.
14. Kuo CY, Huang CT. A reliable transformation method and heterologous expression of beta-glucuronidase in Lentinula edodes. *J Microbiol Methods*. 2008;72(2):111-5. doi: 10.1016/j.mimet.2007.11.006.
15. Vanany I, Shaharoun ABM, Bin A, editors. Barriers and critical success factors towards RFID technology adoption in South-East Asian Healthcare Industry. 3-5, December 2008. Bali: Proceedings of the 9th Asia Pacific Industrial Engineering & Management Systems Conference, Bali, Indonesia; 2008.
16. Reyes PM, Li S, Visich JK. Accessing antecedents and outcomes of RFID implementation in health care. *International Journal of Production Economics*. 2012;136(1):137-50. doi: 10.1016/j.ijpe.2011.09.024.
17. Lai HM, Lin IC, Tseng LT. High-level managers' considerations for RFID adoption in hospitals: an empirical study in Taiwan. *J Med Syst*. 2014;38(2):3. doi: 10.1007/s10916-013-0003-z.
18. Ebrahimi S, Sharifian R, Bastani P. Readiness of hospitals affiliated with Shiraz university of medical sciences for implementation of radio frequency identification technology. *Journal of Health Management & Informatics*. 2015;2(4):120-5.
19. Yao W, Chu C-H, Li Z, editors. The use of RFID in healthcare: Benefits and barriers. 17-19 June 2010; Guangzhou: 2010 IEEE International Conference on RFID-Technology and Applications; 2010. doi: 10.1109/RFID-TA.2010.5529874.
20. Okoniewska B, Graham A, Gavrilova M, Wah D, Gilgen J, Coke J, et al. Multidimensional evaluation of a radio frequency identification wi-fi location tracking system in an acute-care hospital setting. *J Am Med Inform Assoc*. 2012;19(4):674-9. doi: 10.1136/amiajnl-2011-000560.
21. Berkowitz SJ, Wei JL, Halabi S. Migrating to the Modern PACS: Challenges and Opportunities. *Radiographics*. 2018;38(6):1761-72. doi: 10.1148/rg.2018180161.
22. Almalki M, Al-fleit S, Zafar A. Challenges in Implementation of Information System Strategies in Saudi Business Environment: A Case Study of a Bank. *International Journal of Computer Trends and Technology*. 2017;43(1):56-64. doi: 10.14445/22312803/IJCTT-V43P108.
23. Handayani PW, Hidayanto AN, Budi I. User acceptance factors of hospital information systems and related technologies: Systematic review. *Inform Health Soc Care*. 2018;43(4):401-26. doi: 10.1080/17538157.2017.1353999.
24. Esmaeilzadeh P, Sambasivan M, Kumar N, Nezakati H. Adoption of clinical decision

support systems in a developing country: Antecedents and outcomes of physician's threat to perceived professional autonomy. *Int J Med Inform*. 2015;84(8):548-60. doi: 10.1016/j.ijmedinf.2015.03.007.
25. Lakbala P, Dindarloo K. Physicians' perception and attitude toward electronic medical record. *Springerplus*. 2014;3:63. doi: 10.1186/2193-1801-3-63.
26. Ward R. The application of technology acceptance and diffusion of innovation models in healthcare informatics. *health Policy and Technology*. 2013;2(4):222-8. doi: 10.1016/j.hlpt.2013.07.002.
27. Sezgin E, Yıldırım SÖ. A literature review on attitudes of health professionals towards health information systems: from e-health to m-health. *Procedia Technology*. 2014;16:1317-26. doi: 10.1016/j.protcy.2014.10.148.
28. Ahmadian L, Khajouei R, Nejad SS, Ebrahimzadeh M, Nikkar SE. Prioritizing barriers to successful implementation of hospital information systems. *J Med Syst*. 2014;38(12):151. doi: 10.1007/s10916-014-0151-9.
29. Fernandez-Aleman JL, Senor IC, Lozoya PA, Toval A. Security and privacy in electronic health records: a systematic literature review. *J Biomed Inform*. 2013;46(3):541-62. doi: 10.1016/j.jbi.2012.12.003.
30. van Roessel I, Reumann M, Brand A. Potentials and Challenges of the Health Data Cooperative Model. *Public Health Genomics*. 2017;20(6):321-31. doi: 10.1159/000489994.