Vol 2, Issue 4, Oct 2015
Journal of Health Management & Informatics
jhmi.sums.ac.ir
Original Article

Readiness of hospitals affiliated with Shiraz university of medical sciences for implementation of radio frequency identification technology

Saeid Ebrahimi[1], Roxana Sharifian[2*], Peivand Bastani[3]

Received 11 Jul 2015; Accepted 22 Aug 2015

ABSTRACT

Introduction: Applying information technology in healthcare system is one of the most important criteria of the World Health Organization for evaluating the quality of healthcare systems of different countries. Moreover, applying this technology in different parts of health care system can create great potentials for improving the quality of healthcare services. In this regard, Radio Frequency Identification (RFID) technology is one of the most practical technologies in identifying and collecting data. The present study aimed to compare the readiness of Shiraz University of medical sciences hospitals for implementation of RFID system in 2014.

Method: This was a cross-sectional study conducted in 2014. The research population consisted of 110 senior and middle managers. Due to the limited research population, census method was used. The research tool was a questionnaire prepared by the researcher to investigate the hospitals' readiness for implementation of RFID technology. Face and content validity of the questionnaire were approved by the experts. Cronbach's alpha test was run to determine the reliability of the questionnaire (data were considered significant at $p < 0.05$). Also, the data were analyzed in SPSS software using descriptive statistics (mean, standard deviation, and percentage) and inferential statistics (one-way ANOVA).

Results: The study showed that the readiness level of the hospitals was moderate. Comparing the mean of the total readiness level in the hospitals under the study revealed that there was a statistically significant difference between hospital M and other hospitals (P=0.003). However, the total readiness of hospital I was higher than others.

Conclusion: Among 13 hospitals under the study, the hospitals I and A were moderately ready and others were not ready for implementation of RFID technology. Thus, considering various applications and advantages of RFID technology, it is suggested that the hospitals should prepare the budget, improve the technical and communicative infrastructures, and also plan to implement this technology.

Keywords: Radio Frequency Identification (RFID) technology, Implementation readiness, Hospital

►*Please cite this paper as:*
Ebrahimi S, Sharifian R, Bastani P. Readiness of hospitals affiliated with Shiraz university of medical sciences for implementation of radio frequency identification technology. J Health Man & Info. 2015;2(4):120-125.

Introduction

Nowadays, technology is one of the most important elements in different organizations and has remarkable consequences in social, financial, and political systems (1). Among different organizations, healthcare systems are faced with limited resources and increasing costs. Thus, it is obvious that information technology can be applied as an appropriate evaluative tool to control the resources and work process and improve the quality of patient care in these systems (2). On the other hand, healthcare is a very sensitive and vital domain in a way that even a small mistake may lead to irreparable harms to the patients' health. Therefore, applying this technology can be a useful tool for improving the total performance of the hospitals from this point of view (3). Moreover, one of the important factors of World Health Organization (WHO) in evaluating the healthcare system of each country is the use of information technology in health services (4). Applying information technology in different parts of healthcare system, especially hospitals can create great potentials for improving the quality of healthcare services (5). In this regard, one of the most practical technologies is Radio Frequency Identification (RFID) technology. RFID technology is a wireless technology to identify and collect data (6). This technology is an ongoing technology which applies radio frequencies to collect, transfer, and record important data automatically. It is believed that

[1] *Department of Health Information Technology, School of Management and Medical Informatics, Shiraz University of Medical Sciences, Shiraz, Iran*

[2] *Department of Health Information Technology, School of Management and Medical Informatics, Shiraz University of Medical Sciences, Shiraz, Iran*

[3] *Department of Health Service Management, School of Management and Medical Informatics, Shiraz University of Medical Sciences, Shiraz, Iran*

*Corresponding Author: ***R Sharifian,*** *Ghasr-adasht St, 29th Alley, Diamond Building, School of Management and Medical Informatics, Shiraz, Iran, Email: sharifianr@sums.ac.ir.*

RFID technology is the next generation to collect data and trace the properties (7). The structure of a typical RFID technology consists of tag, antenna, data-reader, and software. RFID tag will be attached to the object that is to be traced and data related to that object will be transferred to the data reader via the antenna (8). The data-reader reads the stored data and transfers it to the ongoing software on the computer via appropriate communication channels such as local networks. In fact, RFID technology receives data and transfers it to the data-reader via radio frequencies in a specific limitation (9). Besides all the above, it is worth mentioning that RFID technology is not a new technology. This technology was applied in the World War II for the first time to identify the enemies. Of course the origin of RFID technology dates back to 1950 simultaneous with inventing a radio transmission system by Haris (10). Finally, in July 2004, RFID technology was applied to identify the patients in hospitals and access of the personnel to the patients' documents. After that time, some American hospitals started to implant the RFID chips in the patients' body for better healthcare and management (11). Moreover, this technology could solve many problems in hospitals and makes the health management easier and more efficient due to its wide range of application in tracing and controlling people and objects (12). This technology is helpful in hospitals for concise identification of the patients and appropriate transfer of the information. Also, it can diminish the stealing of babies in hospitals, stealing or losing equipment and medicines, prevent wrong prescription of medicine, and also prevent patients' escapes from hospitals. In this way, application of RFID technology can obtain more satisfaction for the patients and also remarkably decrease the costs by optimizing and improving the performances. However, establishing RFID technology faces serious challenges (6, 8) and it is essential that hospitals prepare all the prerequisites and facilities before establishing this technology and tent to plan effectively before applying it. The importance will become more obvious when we know that the literature review showed that there was almost no study on the related topics, so, in this regard, the present study aimed to determine and compare the readiness level of the hospitals of Shiraz University of Medical Sciences for the implementation of RFID technology which was conducted in 2014.

Methods

This was a cross-sectional descriptive-analytical study which was conducted on thirteen teaching hospitals affiliated with Shiraz University of Medical Sciences in 2014. Research population consisted of 110 senior and middle managers including hospital directors and managers, educational and clinical supervisors, clinical wards incharges, para-clinical wards (laboratory, drugstore, blood bank) incharges, operation room incharges, business and finance affairs incharges, information technology incharges, medical record department incharges, and the incharge of nursing wards. Due to the limited research population and in order to increase access to the opinions of all the different above-mentioned groups, sampling was not performed and census method was applied. To observe the research ethics, the name of the hospitals remained confidential and abbreviations were used instead.

In order to obtain data, a questionnaire was developed by the researcher based on the conceptual model of the readiness level of the hospitals for implementation of RFID technology (13). This questionnaire included two parts to determine the hospitals' readiness regarding different dimensions such as managerial, organizational, economical, technological, ICT, physical, environmental, legal and lawful, cultural, and social humanities to implement RFID technology. The first part of the questionnaire consisted of 7 demographic questions (on age, gender, education, work experience, management experience, familiarity with information technology, and familiarity with RFID technology); also, the second part consisted of 42 structured questions related to the 10 dimensions under the study which were designed based on the Likert scale so that choice 1 indicated strongly disagree and choice 5 strongly agree. Face and content validity of the questionnaire were approved by 5 experts in this field. Cronbach's alpha test was run to determine the reliability of the questionnaire in a way that the questionnaire was given to 30 respondents in the research population and then the Cronbach's alpha was estimated .095 which shows an appropriate reliability for the questionnaire. The reliability of each dimension was higher than 0.5.

The collected data were analyzed in SPSS software using descriptive statistics (mean, standard deviation, and percentage) and inferential statistics (one-way ANOVA).

Results

Personal characteristics

37.3% of the respondents (41 persons) were between 31 to 35 years old. 56.4% of them (62 persons) were women. Most of the respondents (63.6%) had undergraduate degree (70 persons) while 6.4% of them had PhD degree (7 persons). 81.8% of them had ten years of work experience or below (90 persons) and 76.4% had management experience or below (84 persons). Most of the respondents (70 persons) had an average familiarity with information technology while 28.2% of them had a high familiarity with technology (31 persons). 69.1% of the respondents had a little familiarity with RFID technology and only 0.9% of the respondents were familiar with this technology (1 person). The readiness levels of the hospitals under the study for the implementation of RFID technology were investigated in 10 different dimensions, namely managerial, organizational, economical, technological, ICT, physical, environmental, legal and lawful, cultural, and social humanities. The results are displayed in Table 1.

The readiness levels of the hospitals under the study were investigated for the implementation of RFID technology regarding managerial dimension; the results are presented in Table 1. Descriptive statistics showed that in the managerial dimension, the mean and standard deviation of readiness were 2.80 and 0.76, respectively. Moreover, the minimum and maximum means regarding managerial dimension were 1.8 and 3.90, respectively. One-way ANOVA test revealed that there were statistically significant differences between hospitals M and L with other hospitals ($P<0.001$) (Table 2) while hospital D had a better condition in comparison with others (Table 3).

Table 1. Readiness levels of the hospitals under the study for the implementation of RFID technology

Mean	Components	Std. Deviation	Percent of readiness	Minimum	Maximum
Managerial Readiness	2.80	0.76	56	1	2.4
Organizational Readiness	2.71	0.82	54.3	1	4
Economical Readiness	2.40	0.63	48.1	1	3
Technology readiness	2.82	0.71	56.5	1	4.6
ICT Readiness	2.85	0.80	57.1	1	5
Physical Readiness	2.80	0.73	56.1	1	4
Environmental Readiness	2.51	0.86	50.2	1	4.7
Legal and lawful readiness	2.90	0.77	58	1	4.6
Cultural Readiness	2.97	0.62	59.5	1.17	4.5
Social Humanities readiness	2.62	0.67	52.5	1	4.8
Total Readiness	2.74	0.50	54.8	1.26	3.7

Table 2. One-way ANOVA test for comparing the hospitals under the study for implementation of RFID technology regarding 10 dimensions of readiness

Components	Readiness to deploy RFID technology	Sum of Squares	df	Mean Square	F	Sig.
Managerial Readiness	Between Groups	21.299	12	1.775	4.009	.000
	Within Groups	42.941	97	.443		
	Total	64.240	109			
Organizational Readiness	Between Groups	18.647	12	1.554	2.726	.003
	Within Groups	55.288	97	.570		
	Total	73.935	109			
Economical Readiness	Between Groups	7.840	12	.653	1.784	.061
	Within Groups	35.514	97	.366		
	Total	43.354	109			
Technology readiness	Between Groups	8.134	12	.678	1.369	.194
	Within Groups	48.029	97	.495		
	Total	56.163	109			
ICT Readiness	Between Groups	10.654	12	.888	1.454	.155
	Within Groups	59.226	97	.611		
	Total	69.880	109			
Physical Readiness	Between Groups	5.840	12	.487	.892	.558
	Within Groups	52.912	97	.545		
	Total	58.752	109			
Environmental Readiness	Between Groups	13.153	12	1.096	1.538	.124
	Within Groups	69.145	97	.713		
	Total	82.298	109			
Legal and lawful readiness	Between Groups	9.959	12	.830	1.445	.159
	Within Groups	55.719	97	.574		
	Total	65.678	109			
Cultural Readiness	Between Groups	7.425	12	.619	1.680	.083
	Within Groups	35.733	97	.368		
	Total	43.158	109			
Cultural Readiness	Between Groups	7.425	12	.619	1.680	.083
	Within Groups	35.733	97	.368		
	Total	43.158	109			
Social Humanities readiness	Between Groups	12.526	12	1.044	2.677	.004
	Within Groups	37.817	97	.390		
	Total	50.344	109			
Total Readiness	Between Groups	7.083	12	.590	2.738	.003
	Within Groups	20.908	97	.216		
	Total	27.990	109			

Table 3. Means of readiness levels of the hospitals under the study for the implementation of RFID technology

Hospital / Dimensions		A	B	C	D	E	F	G	H	I	J	K	L	M
Managerial Readiness	Means	3.1	3.1	2.8	3.4	3	3.4	2.9	2.7	2.6	2.6	2.5	2.1	1.8
	Std. Deviation	0.50	0.60	0.41	0.62	0.56	0.45	0.22	0.49	0.88	0.99	0.63	0.88	0.99
	N	15	15	10	5	8	7	5	8	10	6	4	7	10
Organizational Readiness	Means	2.9	2.7	2.9	3.3	2.6	3.2	2.7	2.7	3	2.5	2.3	2.1	1.7
	Std. Deviation	0.80	0.67	0.53	0.54	0.81	0.39	0.35	0.61	0.83	1.1	0.37	0.95	0.95
	N	15	15	10	5	8	7	5	8	10	6	4	7	10
Economical Readiness	Means	2.5	2.5	2.7	2.3	2.4	2.5	2.4	2.4	2.4	2.1	2.3	2.4	1.6
	Std. Deviation	0.39	0.59	0.42	0.72	0.77	0.49	0.71	0.62	0.43	0.59	0.70	1	0.47
	N	15	15	10	5	8	7	5	8	10	6	4	7	10
Technology readiness	Means	2.8	2.7	2.8	3.2	2.7	2.6	2.2	2.8	3.3	2.7	3	3	2.3
	Std. Deviation	0.84	0.79	0.60	0.79	0.73	0.59	0.55	0.46	0.92	0.80	0.56	0.84	1
	N	15	15	10	5	8	9	5	8	10	6	4	7	10
ICT Readiness	Means	3.3	2.8	3	2.6	2.8	3	2.8	2.9	3	2.5	2.5	2.7	2.1
	Std. Deviation	0.69	0.70	0.75	0.44	0.61	0.55	0.38	0.24	0.89	0.77	0.38	0.53	1
	N	15	15	10	5	8	9	5	8	10	6	4	7	10
Physical Readiness	Means	2.8	2.8	2.8	3	3	2.6	3	3	3	2.6	2.7	2.4	2.2
	Std. Deviation	0.54	0.83	0.77	0.52	0.81	0.88	0.49	0.56	0.65	0.51	0.95	0.32	1.1
	N	15	15	10	5	8	9	5	8	10	6	4	7	10
Environmental Readiness	Means	2.7	2.3	2.9	2.7	2.5	2.3	2	2.2	3.1	2.1	2.4	2.6	1.9
	Std. Deviation	0.85	0.67	0.65	0.73	0.76	0.51	1.3	.83	0.99	1	0.98	0.88	0.85
	N	15	15	10	5	8	7	5	8	10	6	4	7	10
Legal and lawful Readiness	Means	3.2	3	2.9	3.1	2.7	2.8	2.5	2.7	3.1	2.2	3.5	2.8	2.4
	Std. Deviation	0.56	0.67	0.49	0.76	0.57	0.99	0.86	0.63	0.75	0.86	0.79	0.71	1.1
	N	15	15	10	5	8	7	5	8	10	6	4	7	10
Cultural Readiness	Means	3	3.1	2.9	3	2.7	3.1	3.3	3.1	3.2	2.6	3.2	2.5	2.4
	Std. Deviation	0.69	0.54	0.44	0.43	0.64	0.68	0.33	0.44	0.53	0.28	0.67	0.80	0.84
	N	15	15	10	5	8	7	5	8	10	6	4	7	10
Human Readiness	Means	3.1	2.5	2.3	2.7	2.7	2.4	2.4	2.6	3	2.3	2.8	2.4	1.9
	Std. Deviation	0.63	0.62	0.47	0.73	0.56	0.43	0.27	0.28	0.69	0.74	1.3	0.72	0.53
	N	15	15	10	5	8	7	5	8	10	6	4	7	10

The results considering ICT level of readiness in the studied hospitals showed that the mean and standard deviation of the hospitals' readiness in this dimension were 2.85 and 0.85, respectively. Moreover, the minimum and maximum readiness means regarding ICT readiness were 2.16 and 3.33, respectively (Table 1). One-way ANOVA revealed that there was not any statistically significant difference among the hospitals' readiness regarding ICT readiness (P=0.155) (Table 2). However, Hospital A had a higher level of readiness for the implementation of RFID technology regarding ICT readiness (Table 2).

Descriptive statistics revealed that the mean and standard deviation of physical readiness were 2.80 and 0.73, respectively and the minimum and the maximum means were 2.26 and 3.03, respectively (Table 1). One-way ANOVA test revealed that there was no statistically significant difference among the hospitals (P=0.558) (Table 2) Hospital E had a higher readiness level among other hospitals regarding physical readiness (Table 3).

The readiness level in the environmental dimension was investigated and presented in Table 1. These results revealed that the mean and the standard deviation of the readiness levels regarding environmental readiness were 2.51 and 0.86, respectively. Moreover, the minimum and the maximum readiness means were 1.92 and 3.10, respectively. One-way ANOVA test revealed that there was no statistically significant difference between the hospitals' readiness for implementation of RFID technology regarding environmental readiness (Table 2) However, hospital I had a higher readiness level for the implementation of RFID technology regarding environmental readiness (Table 3).

Regarding legal and lawful readiness of the hospitals under the study which is shown in Table 1, the results indicated that the mean and standard deviation of the hospitals' readiness were 2.90 and 0.77, respectively. The minimum and maximum means were 2.46 and 3.50. One-way ANOVA test revealed that there was no statistically significant difference among the hospitals for the implementation of RFID technology regarding legal and lawful readiness (Table 2). It is worth mentioning that hospital K had a higher readiness level for implementation of RFID technology regarding legal and lawful dimensions (Table 3).

Regarding cultural dimension, the hospitals under the study were investigated and presented in Table 1. The results of descriptive statistics indicated that the mean and standard deviation were 2.97 and 0.62, respectively. The minimum and maximum readiness means were 2.46 and 3.33, respectively. Comparison of different hospitals by using one-way ANOVA revealed that there was no any statistically significant difference among the hospitals for implementation of RFID technology regarding cultural dimension (Table 2).

The readiness levels of the hospitals under the study regarding social humanities dimension were investigated and shown in Table 1. The mean and standard deviation were 2.62 and 0.67, respectively. The minimum and maximum level of the hospitals' readiness regarding social humanities dimension were 1.93 and 3.13, respectively. One-way ANOVA test indicated that there were statistically significant differences between the hospitals A, L, and M with other hospitals (P=0.004) (Table 2) Hospital A had a higher readiness level among other hospitals regarding social humanities dimension (Table 3).

The total readiness level of the hospitals under the study regarding the ten dimensions were investigated and shown in Table 1. The mean and standard deviation of the readiness level for the implementation of RFID technology regarding all dimensions were 2.74 and 0.50, respectively. The minimum and maximum means were 1.93 and 3.00, respectively. One-way ANOVA test revealed that there was a statistically significant difference between the hospital M and other hospitals (P=0.003) (Table 2) However, hospital I had a higher level of readiness among other hospitals (Table 3).

Discussion

Results showed that there was a moderate level of readiness among the studied hospitals for installing RFID. It may be due to the fact that the present technology is not understandable for all the hospitals and it needs to plan for related workshops or conferences increasing the managers` knowledge before any decision of establishing RFID.

Other results indicated that the economical readiness had the minimum level and the social and legal dimensions had the highest rate of readiness together. Many reasons can be recolonized justifying these results considering lack of governmental budget, low levels of hospitals' income and no sense of need to apply and attend these changes. In this regard, previous studies have shown that high costs, time and costs for training the users, and rejection by the users are the important factors in decreasing the readiness levels of the hospitals for the implementation of RFID technology which correspond to the present study (14,15). Other studies like that of Fisher and Munahan mentioned that the complexity of applying RFID technology is due to the lack of appropriate technical knowledge, lack of trust from the users, inappropriateness of technological, communicational, physical infrastructures in the hospitals for implementation of RFID technology; this corresponds to the results of the present study (16). So, it is very important to improve the users' abilities and increase their knowledge through a pre-planned and comprehensive table from the policy making level before starting any phase for implementation of new technologies and RFID as well. It is also highly recommended that the authorities go through the necessary infrastructures and prerequisites of establishing RFID in hospitals before the actual phases of utilization of the technology.

Moreover, Schoenburg in his study mentioned that managerial factors seriously affect the implementation of RFID technology. In this regard, some managers are still suspicious about applying this technology. Economic factors also affect the implementation of RFID technology which corresponds to the present study (17).

Furthermore, Gangialusi et al in their study emphasized some problems such as conflict of RFID frequencies with electromagnetic frequencies of the devices in the hospitals and also lack of communicational and physical readiness that affects the implementation of RFID technology; this again corresponds to the results of the present study (18) that all confirmed the necessity of paying enough attention to the infrastructures both technically and physically. Oscar et al emphasized the organizational and hospital readiness for the implementation of RFID technology. They mentioned technical problems, physical and technical infrastructural problems, and the budget as the important factors in the implementation of RFID technology (19).

Finally, regarding various applications and benefits of RFID technology and also considering the present state of the hospitals under the study, they are recommended to achieve and devote the necessary budget and financial recourses along with improvement of the technical and communicational infrastructures in order to establish RFID in these hospitals.

Conclusion

Considering the potential advantages of RFID for hospitals, it is important to investigate the feasibility of hospitals through different and comprehensive dimensions mentioned in the study (managerial, organizational, economical, technological, ICT, physical, environmental, legal and lawful, cultural, and social humanities) and try to prepare the standard level of readiness for these hospitals before thinking to implement this technology.

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