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# Security, Privacy and Ethical Barriers in Adoption of RFID in Healthcare Sector (Iranian Hospitals)

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**Abstract:** Radio Frequency Identification (RFID) is a technology that can be applied by hospitals to improve operational efficiency and to gain a competitive advantage over their competitors with today's highly competitive market in the healthcare industry. This study explores the barriers of RFID adoption in Iranian healthcare industry context as one of the developing countries from the perspective of healthcare decision makers, managers and IT professionals. In these days hospitals need to enhance the safety and quality of healthcare if they want to remain in the competition with other hospitals. It has been proved that RFID system in healthcare has the potential to increase the patient safety, decrease the operational cost and enhances the tracking of items and humans and real time management of hospital equipment's. Although, such technology has been adopted and implemented in countries such as USA and European countries, the rate of adoption in developing countries is still very low as compared to developed countries, despite the great potential of system to solve current problems of healthcare. A case study research with qualitative approach has been chosen for this study. The results show that organizational and environmental barriers, government policy and security and privacy concerns have an effect on the intent to adopt RFID in hospitals developing countries such as Iran. The results of this study will help decision makers as well as managers in the healthcare industry to better understand the determinants of RFID adoption. Additionally, it will assist in the process of RFID adoption and therefore, spread the usage of RFID technology in more hospitals.

**Key words:** RFID, security and privacy, Iran's hospital, healthcare, adoption

## INTRODUCTION

Many people annually die due to medication related errors in all over the world. There are many reasons that could lead to such errors, such as similar medication names, labels and packaging, as well as staff shortages, fatigue and carelessness (Berman, 2004; Crawford *et al*., 2003: Walton, 2004). To address this issue, hospitals have begun to use various technologies to guard the medication activities. Radio Frequency Identification (RFID) technology a technology that has various applications (Chen *et al*., 2009; Lai *et al*., 2007) which assist in the daily work of hospitals such as reducing medication errors and increasing patient safety. Through RFID, healthcare businesses can improve their organizational performance and competitiveness (Lin and Ho, 2009; Loebbecke and Palmer, 2006; Castro *et al*., 2013). Besides operations improvements, RFID can also help improve patients' safety (Vanany and Shaharoun, 2008; Wickboldt and Piramuthu, 2012). Despite the great promise of RFID in hospitals, not all hospitals adopt RFID without hesitation. Hence, the issue of "what factors influencing the adoption of RFID in a healthcare setting" becomes an important question for all healthcare administrators.

It is believed that RFID is capable of achieving these goals and become critical in healthcare organizations (Wang *et al*., 2006). Taking in to consideration of increasing patient's safety, better tracking of drug supply and real time management of hospital equipment's, RFID is quite capable of lowering operating cost and enhancing patient safety. RFID in Healthcare East Conference 2010 revealed that hospitals in USA already using RFID in their operational process. In a conference the news was published regarding the improvement of patient care, cost reduction and efficiency in operation of medical processes with the help of RFID which showed/shows that it can provide major benefits to the health-care sector across USA. RFID journals and internet articles also reported many healthcare organizations in the world such as United States, Netherlands, Italy and other countries are successfully implemented RFID technology to improve efficiency of their operations and achieve organizations objective strategy. However the latest conference of RFID which was held in Abu Dhabi, UAE, showed that adoption of radio frequency identification in the Middle Eastern countries is a way behind the developed countries such as USA and European countries.

Although, the conference revealed that the intention is beginning to grow in the Middle East just similar to Malaysian hospitals but this growing intention of RFID in developing countries is not without difficulties and problems.

Iranian hospitals are also dealing with RFID adoption issues and lag behind developed countries regarding RFID adoption. Based on the interview with one of the managers of Iranian hospitals, none of the hospitals in Iran has implemented this technology. The chief of the department of "noncontagious disease" of the ministry of health in IRAN indicated that 6% of death that occurs in hospitals are related to Hospital Acquired Infection (HAI). He also admitted that 600, 000 people are infected with Hospital Acquired Infection (HAI), yearly in the hospitals. These statistics show that there is a huge problem regarding detecting, tracing, cleaning the equipment's which are in touch with patients. Such process can be solved with automation of process and detection of forgotten and dirty equipment's. RFID technology has this potential to verify that these processes have been completed efficiently (Azevedo and Ferreira, 2010). Moreover, despite the claims of hospital authorities who indicate that hospitals are suffering from drug theft, patients escape, lack of speed in work flow process, adoption of RFID which could be a solution to all these problems have been hold still and decision makers are hesitating to adopt the technology. Organizations need to understand the barriers of RFID adoption in order to achieve full outcomes regarding adoption of RFID.

Past literature has attempted to investigate the factors that affect the adoption of RFID in retail [18http://link.springer.com/article/10.1007/s10916-014-0172-4-CR13],logistics [19http://link.springer. com/article/10.1007/s10916-014-0172-4-CR14]and manufacturing [20http://link.springer. com/article/10.1007/ s10916-014-0172-4-CR15] but there is a lack of empirical research on the determinants of RFID adoption in the healthcare industry. The studies in this industry focus more on the barriers of RFID adoption (Vanany and Shaharoun, 2008), applications of RFID in the healthcare industry [21http://link.springer.com/article/10.1007/s10916-014-0172-4-CR16, 22http://link.springer.com/article/10.1007/s10916-014-0172-4 - CR17] and risk associated with RFID in hospitals [23http://link.springer.com/article/10.1007/s10916-014-0172-4-CR18, Rosenbaum, 2014 http://link.springer.com/article/10.1007/s10916-014-0172-4-CR19]. Therefore, to date, factors that drive RFID adoption in hospitals are still not clearly or fully identified. This Lack of resource indicates that there is urgent need to start a systematic research to identifying barriers of RFID adoption in healthcare. To fill up this gap, the determinants of RFID adoption in hospitals are investigated in the present study. Furthermore, although, the adoption of RFID within a hospital needs to involve decision makers (top and mid managers) and RFID users in hospitals (healthcare and supporting staff), little research, if any, has been done to elucidate the moderating effect of the occupational level. Finally, most of the previous RFID studies were limited to management level's willingness to adopt RFID [24http://link.springer.com/article/10.1007/s10916-014-0172-4-CR20, 26http://link.springer.com/article/10.1007/ s10916-014-0172-4 - CR21]. The result of this study could be helpful for better understanding and identifying barriers which are affecting the adoption of RFID technology in healthcare sector in developing countries such as Iran from the perspective of healthcare decision makers, technical and experts of RFID technology to find out about common and usual problems in hospitals regarding adoption of RFID. This research focuses on RFID adoption in developing countrie's hospitals based on previous theories, through the examination and identification of RFID barriers in domains of privacy, security and ethical.

**RFID technology in healthcare:** RFID is a contactless technology which benefits from radio frequency signals in order to send and receive data wirelessly, from a distance, from RFID tags or transponders to RFID readers. Purpose of RFID technology is to automate identification and to trigger the processes which lead to data collection or automation of manual processes.

RFID technology can be used in hospitals in different ways: Tracking, identification and verification, automatic data collection and transfer, sensing, alerts and trigging are identified as five common RFID functions that would be possible to see in healthcare process (Yao *et al*., 2010). RFID technologies can support tools greatly for tracing the movement of either individuals or objects or both (Yao *et al*., 2010). In a situation which tracking of an individual is required, RFID-enabled tracking can demonstrate an individual's location in real-time or their movement through critical choke points such as entry and exit points of nominated areas. "Identification and authentication of patients are promising areas for use of RFID". Misidentification has been described as a common root of healthcare errors which can be decreased by the help of RFID system (Yao *et al*., 2010). Normally the primary method of patient identification in many hospitals depends on hand-written wristbands which can cause an illegible or be prone to spelling errors or both. As an example RFID system has implemented in for university college hospital in galway, Ireland, for a patient identification system to enhance safety (Yao *et al*., 2010).

Sensing capability of RFID has an encouraging function in diagnosing patient conditions. This ability of RFID technology can be categorized as a part of e-health applications which gives the hospitals and other related healthcare systems the potential to manage the devices from distance. Moreover, these sensing functions also can be helpful when it comes to tracking of equipment's and repairing status and general software patching levels. Another function of RFID sensing is for the system access security purpose which manages entering and exiting of staff based on their security level in the institution.

Automation is an important capability of RFID system which can decrease time processing and related human errors, for example, there is potential to order a specific drugs and medical tools automatically from market when they become low in the storage. However, unlike previous promising application of RFID in healthcare, using full potential of this application required integration of antenna and reader in to HIS system or other healthcare delivery systems. With this system in place, healthcare personnel don't need to spend time on paperwork, filling and processing forms if all these works are done through automation system. Alfred hospital, Melbourne, Australia, has integrated RFID system in to its HIS system in order to establish intelligent clinical diagnosis and treatment support system (Yao *et al*., 2010).

RFID system can help blind or short sight people for their movement in the indoor environment (Yao *et al*., 2010). An indoor navigation Applications involving alerts and triggers are deployed to keep patients safe from hazardous incidents or emergencies during the surgery, blood transfusion, drug administration, hand hygiene monitoring, etc (Yao *et al*., 2010). The buzzer will be triggered and the data will be sending in to the system when a staff incorrectly put their hands in to machine or doing the process not in an appropriate order.

**Benefits and barriers of RFID in healthcare:** There are diverse benefits for adoption of RFID in healthcare system. Benefit of adoption of RFID in healthcare is not limited to cost reduction or improvement of efficiency by tracking of individuals or items but by decreasing the amount of medical error rate and enhancing patient safety (Vanany and Shaharoun, 2008). Nearly 44,000-98,000 deaths have been reported each year due to medical errors and system errors (Vanany and Shaharoun, 2008). Almost all of the US hospitals required to enhance patient safety to prevent common medical errors (Vanany and Shaharoun, 2008).

Theft and counterfeit are the ultimate causes that the US FDA mandated healthcare industry to add RFID tags on drugs that are selling in U. S. Many pharmaceutical companies integrated RFID tags on drugs packages, some of them include, Pfizer and Glaxo Smith Kline (Vanany and Shaharoun, 2008).

In addition to that RFID system is capable of enhancing patient treatments and safety by decreasing medical errors, improving the security of medicine, the environment and enhancing patient compliance (Wicks *et al*., 2006). The FDA estimates nearly 500, 000 errors, although based on the FDA estimation nearly 50% of drug mistakes are preventable by using information technology (Wicks *et al*., 2006). Hospital's aims are to enhance operational process and patient workflow in order to save costs and increase patient satisfaction (Yao *et al*., 2010). With RFID's ability to capture and store data automatically, all manual procedures of data capturing can be automated and can be used for hospital efficiency improvement (Yao *et al*., 2010).

These days lots of hospitals face a growth in issues such as, misplaced or stolen medical tools. Hospitals such as advocate good shepherd in the US save 10% of inventory lost due to adoption of RFID, Holy Name Hospital in U.S., reduced rental cost and improved time saving by adoption of RFID and tagging the medical equipment on finding medical tools. The problem of healthcare system is that, doctors and nurses were wasting 20-30% of their time finding their required devices and they were losing approximately 10-15% of their equipment each year. RFID usage saves nurse's time in finding the devices, improves their productivity, helps medical staff to dedicate more time on patients care. In addition to previous benefits, RFID system has a great reading potential with a capability of reading tags in a non-line-of-site and with better accuracy as compared to prior products such as barcodes (Azevedo and Ferreira, 2010). Moreover, manual process of data collection will be enhanced because they do not use optics for reading tags (Fisher, 2006).

RFID system help managers and administrators to track the way staff follow the rules. RFID system has a capability to transfer database on time-interval and report if the procedures have been completed perfectly or if there is a gap or inefficiency somewhere in the process. One of the obvious examples of tracking the procedures could be tracking the process of hand-washing of medical personnel for the purpose of decreasing the spread of infections in hospitals. Detecting the location and identifying patients can also be one of RFID benefits to

healthcare System. Belgian University Hospital might be one of the first to use RFID system not only to locate patients but to identify them by integrating RTLS (Real time location system) tags into medical equipment to send patients health information and emergency alerts. RFID technology can also be used for enhancing the security of a hospital or healthcare center by controlling who get access to the restricted environment (Wicks *et al*., 2006). RFID tags which have been provided to employees and patients have a potential to show when and where a restricted area have been breached by triggering the alarm to alert the security staff (Wicks *et al*., 2006).

**Benefits of RFID adoption identified from literature:**

- Anti-theft and drug counterfeit
- Improve patient safety
- Improved medical process
- Improve patient satisfaction
- Reducing time and cost
- Improve productivity
- Real time-asset management
- Bounding health workers to follow the procedures
- Improve patient monitoring
- Improve physical security

Building an RFID system in hospitals environment is quite difficult (Al-Nahas and Deogun, 2007). In addition to difficulties of building software and hardware system in hospital, RFID systems are utilized in safety critical settings which critical patient's information are at stake, therefore; such conditions makes it more difficult to be adjusted in healthcare setting. Based on literature review, not so many researchers have studied the adoption barriers of RFID system in healthcare setting but finding a research which investigated this issue in developing countries is even scarcer. In this section, main challenges in adoption of RFID system in healthcare setting are presented. As it has mentioned more than half of USA hospitals adopted RFID technology and the rate of adoption in Europe is on the rise, therefore there should be some barriers especially in developing countries which are preventing them from adaptation of such technology. In this section common barriers of RFID adoption in healthcare are investigated shows common barriers which have been identified in previous studies.

**Barriers of RFID adoption:**

- Wireless infrastructure/connectivity problem
- Interference on medical equipment
- Lack of system integration and Interoperability
- Cost of RFID system
- Difficulty in calculating ROI
- Lack of RFID standards
- Privacy and ethical issues
- Read accuracy and reliability of data
- Lack of RFID knowledge of organizations and case study
- Security issues
- Resistance of staff and change management issues
- Lack of government support
- Lack of vendor support

**Model conceptualization:** Extensive literature reviews on the adoption of RFID technology in an organization such as a hospital shows that several determinants can positively or negatively influence the adoption process [e.g.25,26http://link.springer.com/article/10.1007/s10916-014-0172-4-CR22]. Taking these published suggested determinants into consideration, coupled with local scenarios, this study will focus on four variables as the determinants to RFID adoption intention in the local healthcare industry, namely organizational, environmental, privacy, ethical and security and technical (Fig. 1). Occupational level is considered as a moderating variable to explore the potential difference in drivers of RFID adoption intention among decision makers and RFID technology users in hospitals. In the following sections, the relationship will be established.

The aim of conceptualization is to explain graphically or in narrative form, the important issues that are going to be studied. This helps the researcher to specify who and what will be researched. In order to collect data and answer the research questions, a conceptualization of the literature review will be presented here. Theories that are related to research question will be presented in this section.

**Organizational barriers:** Cost of RFID system is a major barrier to adoption (Azevedo and Ferreira, 2010), this cost includes obtaining tags, applying tags, purchasing tag readers, developing software programs and database systems and integrating and maintaining the systems (Wang *et al*., 2006). Unclearness of ROI and difficulty of calculation of improvement of work process influence the adoption.

The lack of RFID knowledge of organizations, their insufficient awareness of the potential benefits (Lee and Shim, 2007) and lack of detailed published case studies on the implementation of RFID (Li *et al*., 2010a) may be preventing organizations from adopting RFID.

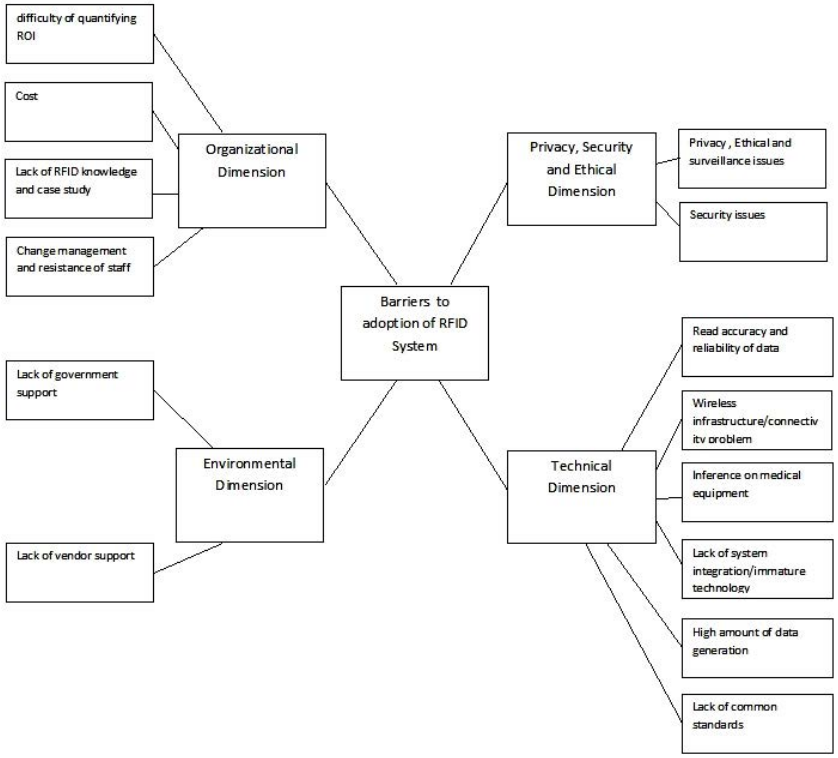


Fig. 1: Proposed theoretical model

Human beings who use the technology are creatures of habit and any change in working practices will be confronted with their resistance which might lead to prevention and inhabitation of adoption. Lack of internal support specially physicians, has been mentioned as a major inhibitor for hospitals trying to implement IT (Wang *et al*., 2006).

**Environmental barriers:** Without governmental action, it would be very difficult to adopt new technologies and processes (Lin and Ho, 2009). Government support can consist of variety of issues such tax break, regulation etc., which lack of will act as barrier. As a result, lack governmental support can act as barrier to adoption.

Not many organizations have RFID expertise in their organization which make them dependent on the service and support of RFID vendor. Therefore; lack of vendor support can cause system failure or even not adopting the system in a first place (Li *et al*., 2010b). As it has been mentioned by Lee, support of vendors may be a key enabler of technology acceptance.

**Privacy, ethical and security barriers:**Privacy issue raised by technology is one of the factors that slow down the adoption of RFID. The feeling of being watched by hospital administrators during break time, patient care, etc have caused many nurse union in hospital to prevent the adoption of technology (Fisher and Monahan, 2008). RFID systems cause a major ethical concern regarding privacy violation because of its surveillance potential which might act as barrier to adoption of technology (Yao *et al*., 2010). Surve illance capability of RFID can put pressure on nurses to do vigorous labor and cause privacy and social conservancy (Fisher and Monahan, 2008).

The level of security of RFID system can be counted as disadvantage of system (Azevedo and Ferreira, 2010). There are many security threats regarding RFID adoption such as eavesdropping on communication of tag and reader to capture a data (Al-Nahas and Deogun, 2007), skimming interference, hacking, cloning and fraud. Therefore, lack of security of systems can be serious barriers for adoption of technology (Yao *et al*., 2010;Vanany and Shaharros, 2008)

**Technical barriers:** Lack of reliability of RFID captured data can cause analysis and understanding of information difficultly and as a result create mistrust in the system and

count as barrier for adoption (Yao *et al*., 2010). Lack of accuracy of RFID system in mission critical environment such as OR room in hospital is also affect the adoption.

Wireless infrastructure and connectivity problem has been identified as barrier for adoption of technology. Due to the previous fact, physical infrastructure of hospitals produce dead zones which reduce the efficiency of system.

Radio frequency electromagnetic radiation may interfere with sensitive medical devices in healthcare and might cause danger to patient safety. As a result it makes the adoption decision difficult for healthcare executives (Yao *et al*., 2010; Al-Nahas and Deogun, 2007)

One of the serious issues which hinder the adoption of RFID in hospitals is lack of interoperability and integration of RFID system with hospitals information system (Vanany and Shaharoun, 2008; Fisher, 2006)

High amount of data generation and data cleansing of RFID system is also a major barrier for adoption of system (Wang *et al*., 2006). Result of case studies shows that significant amount of noise and "dirty data" are generated from an RFID-based system as challenge for implementation of system.

Lack of commonly accepted industrial standards prohibits RFID deployment in large scale including standards of RFID data structure, air-interface and local interface (Yao *et al*., 2010).

## MARTERIALS AND METHODS

Every study requires guideline and frame of reference to organize and systematize its data and determine the path to research question. In order to approach and investigate the barriers to adoption of RFID, the first step is to investigate the articles which are using technology adoption theories. Among various theories of adoption of technology in organizations such as Davis's and Tornatzky and Fleischer's (Tornatzky *et al*., 1990), framework of Chun and Chung has been adopted in order to integrate the barriers of RFID adoption into framework. In addition to Tornatzky and Fleischer's TOE framework which address organizational, environmental and technological dimensions, Chun and Chung's framework added privacy, security and ethical dimension to their framework in order to identify the important factors which affect organization's decision regarding adoption of RFID technology. It should be mentioned that only the upper layer of framework of Chun and Chung has been used as skeleton for main framework and factors which they have used as body of this framework has been omitted and instead of those factors, barriers which have been found in a literature review have been integrated into the framework of Chun and Chung.

This study concentrates on hospitals because hospitals are major part of healthcare industry. The factors of this study are based on literature reviews that explored the barriers and benefits of RFID adoption which was discussed in the previous section. Qualitative research have been chosen for this study because the data needs to be collected from those who are currently working in the healthcare environment and are in position of adoption of technology and tremendously aware of problems of adoption of technology in healthcare system. Nature of qualitative approach gives the interviewees the opportunity to express their point of view regarding research questions without concerning about lack of time and describing the issues which might not be described in quantitative approach. Case study has been chosen as research strategy because the purpose of this study is to get a deeper knowledge regarding the barriers of RFID adoption in healthcare environment in developing countries. For this purpose multiple large hospitals has been chosen for investigation to determine what could be the barriers from perspective of hospital executives and IT managers. Gathering data from each of these hospitals could be a clue to answer research questions and reveal the purpose of study.

The research started first by reviewing the previous work and literature review, next a frame of reference will be built based on previous theories of technology adopted and tailored according to requirements of this research. Then the frame of reference will be used as a guideline to make interview guide and questions. In this study>one source of evidence have been provided during data gathering phase which include documentation and interviews in order to complement each other. Documentation that has been used includes journals and books of theories to demonstrate the valid picture of theory and interviews to collect the fresh and recent data from investigated cases. Interviews are semi structured because they help to let the respondent speak without boundary and provide detailed information on the subject.

The sample selection criteria will be based on three hospitals and University of Olom Pezeshki. From these four cases, six respondents are chosen based on their position in hospital's organizational hierarchy, RFID knowledge and their influence regarding adoption of new technologies in hospitals.

Process of sampling are based on judgmental sampling because all of respondents have been in this

field for so long and totally aware of problems and possible barriers which hospitals are facing at the moment regarding adoption of new technologies and RFID system. In addition to that, all of the respondents have managerial background in their career and they have experienced previous technology adoption in hospitals. Respondent's titles are: Hospital internal, two head of IT department, two IT managers and IT professional.

When the interview part have been done this research use pattern matching for data analyzing due to this method gives the researcher the ability to compare and match the answers and sentences with previous studies and research frame of reference to identify the similarities and differences of barriers of developing countries with the developed ones. In order to increase reliability of research all the interview sessions have been recorded with permission of interviewees, to improve analysis of research process and prevention of missing a word or falsification. All the interviewees have been treated in the same manner with the same questions and interview guide. Moreover, to increase the validity and generality of this research three different hospitals are chosen for the interviews.

## RESULTS AND DISCUSSION

Before examining barriers, this study identified three promising areas that RFID can be more beneficial in context of the Iranian hospital environment. First, for the purpose of identification and authentication of staff. Second, item management in hospitals warehouses to facilitate the process and theft prevention. And finally, to evaluate staff functionality and work process in hospitals. Theft, difficulty of managing gigantic warehouses and facilitating the process of item management were the reasons which have been identified by respondents for adoption of RFID in hospitals warehouses. Leaving post without informing supervisors, doing personal matters and enhancing physical security are the main reasons that hospitals willing to use authentication and identifications of staff by RFJD usage. Finally, identifying bottleneck and crowded areas of hospitals and work process evaluation are the main reasons for evaluation of staff functionality.

**Organization barriers:** As it has been predicted, majority of respondents mentioned cost of RFID system and Tags as barriers to adoption of RFID. Absence of ROI calculation and difficulty of such a process was showed in most of Shiraz hospitals and indicated by 5 out of 6 respondents which shows the criticality and difficulty of ROI calculation when it comes to adopt RFID in healthcare. The reason is because the person in charge of providing such statistics believes that by showing the real statistics he/she will lose the job or will get fined if the result was unacceptable therefore the result never be provided to authorities for decision making and evaluation. The other reason is because these processes are rarely conduced in hospitals.

More than half of respondents described lack of RFID and IT knowledge of hospitals as barrier to RFID adoption. They believed IT department of hospital is responsible for not researching and investigating on existence and capabilities of such technology for healthcare. All the interviewees have mentioned resistance of staff and change management issues as barrier. They believed the lack of IT knowledge of staff (nurses, doctors, etc.,) and absence of job security in IRAN, makes staff to resist and even sabotaging the system to secure their job or prevent possible replacement.

**Environmental barriers:** Nearly all the respondents described the lack of vendor support as obstacle to RFID adoption. The result showed that hospitals in Shiraz suffering more from absence of vendors advertisement and shortage of RFID vendors than the actual support which comes from vendors after the implementation. Among all respondents only one respondent mentioned lack of government support as a barrier to RFID adoption. According to him because public hospital's budget comes from government, they are highly rely on governmental support to adopt the technology. However; the rest of respondents totally count out government support because they believe it is not going to happen and government did not help them before regarding adoption of new technology.

**Privacy/ethical/security barriers:** Strangely, none of the respondents chose privacy, ethical and security issues as barriers to RFID adoption. Mostly, their explanations showed that, they are not aware of "work intensification" and privacy issues and they did not believe that such things even exist. According to one of the respondents the main purpose of RFID is to trace objects and humans, therefore, it cannot be a barrier and staff need to dedicate their working hours to hospitals and not for personal matters. Such comments indicated that the subject of privacy and ethical matters are not completely defined among personnel and decision makers of the Iranian hospitals because all of them have foggy description of

Table 1: Technogical barriers

| Barriers factors | Percentage | Rank |
|---|---|---|
| **Organizational barriers** | | |
| Cost of RFID | 21. 5 | 3 |
| Lack of ROI in business | 26. 3 | 2 |
| Lack of RFID knowledge | 21. 5 | 3 |
| Resistance of staff and change management issues | 31. 5 | 1 |
| **Environmental barriers** | | |
| Lack of vendor support | 83. 3 | 1 |
| Lack of government support | 16. 6 | 2 |
| **Privacy/ethical/security barriers** | | |
| Privacy and ethical | 17.3 | 0 |
| Security | 15.2 | 0 |
| **Technological barriers** | | |
| Wireless infrastructure and connectivity problems | 55. 5 | 1 |
| Reliability of data | 22. 2 | 2 |
| Radio frequency interference | 11. 1 | 3 |
| Lack of interoperability of RFID with other systems | 11. 1 | 3 |
| Lack of RFID standards | 0 | 4 |

what is privacy and how this privacy can be threatened by technology. Regarding security barriers, the reaction was the same among respondents. They mentioned that if we wanted to use the RFID system for personnel tracing, authentication purpose or tagging patients, we are not going to fill the tags with important information. They did not believe someone is interested on capturing patients and personnel data which are in the tags. These comments show lack of knowledge of hospital authorities regarding what kind of information is valuable to others. Moreover, they believe the risk is very remote, therefore; they do not consider security matters as a barrier to adoption.

**Technological barrier:** Wireless infrastructure of hospitals and connectivity problems are the barriers in almost all the interviewed hospitals. Based on the respondent's comments because of special condition and infrastructure of hospitals, there is a connectivity problem in certain areas such as operation rooms or MRI rooms which can cause problem regarding getting signal from tags. Although reliability of captured data is very important in adoption process less than half of respondents addressing this issue. Only 1 out of 6 respondents mentioned lack of interoperability and integration of RFID systems with other hospital systems as barrier to adoption of RFID (Table 1).

Surprisingly none of the respondents count lack of common industrial standards as barrier to RFID adoptions. The reason could be because hospitals are independent from each other therefore; using different standards might not harm the adoption process. The other reason for their answers could be because they believe that using non standards RF signal can still work in hospitals without affecting other devices.

**Description and comparison privacy, ethical and security barriers:** Some of respondents chose privacy, ethical and security barriers as barrier to RFID adoption. Mostly, their explanations show that, they aren't aware of "work intensification" and privacy issues and they did believe that such thing can existed. One of the respondents against this believe said that the main purpose of RFID is to trace objects and humans, therefore; it can't be a barrier and staffs need to dedicate their working hours to hospitals and not for personal matters. Such comments show that the subject of privacy and ethical matters are not completely define among personnel and decision makers of Iranian hospitals because all of them have foggy description of what is privacy and how this privacy can be threaten by technology. Addressing this issue is a huge problem in Iranian healthcare system and needs to be defined and addressed soon.

Regarding security barriers, the reaction fluctuates. In this age of cyber-crime, security is a major concern and barrier to any technology. Security is defined as the protection of transaction and customer details from both internal and external fraud and criminal usage. If the security doubt of a certain innovation is not addressed or solved, it will severely impact the adoption intention towards the innovation. Some mentioned that if we wanted to use the RFID system for personnel tracing, authentication purpose or tagging patients, we are not going to fill the tags with important information, they meanwhile some believe that data security is an important consideration in the health care domain. When an RFID tag is associated with a patient, it can contain a unique identification number that can associate with any type of personal information, such as patient name, gender, home address, medical history. This information is highly mobile and sensitive. The level of security of RFID systems can be counted as a disadvantage of the system. There are many security threats regarding RFID adoption such as eavesdropping on the communication between the tag and the reader during data capture, skimming interference, hacking, cloning and fraud. Therefore; lack of security of systems can be a serious barrier for adoption of the technology. These comments show, lack of knowledge of hospital authorities regarding what kind of information is valuable to others that opens the discussion of data classification which is out of scope of this study. The other reason which makes hospital authorities careless about security issues of RFID is feeling of hacking and stealing by criminals. Because of novelty of usage of RFID for data gathering purpose in hospital almost everyone fears about the system to hack, steal or do harm to the system and they believe such risk is very common, therefore, they do consider security matters as barrier to adoption (Table 2).

Table 2: Privacy, ethical and security barriers

| Variables | Case 1a | Case 1b | Case 2a | Case 2b | Case 3 | Case4 | Theory |
|---|---|---|---|---|---|---|---|
| Privacy and ethical | Privacy is the barrier | Privacy is the barrier | No | Ethic is the barrier | No | Privacy is the barrier | RFID systems cause a major ethical concern regarding privacy violation because of its surveillance potential which might act as barrier to of technology adoption (Yao *et al*., 2010) |
| Security | Security is the barrier | No | Security is the barrier | Security is the barrier | No | Security is the barrier | Without governmental action, it be very difficult to adopt new technologies and processes (Lin and Ho, 2009). government support can consist of variety of issues such tax break, regulation etc. which lack of will act as barrier |

Table 3: Privacy, ethical and security critical success factors

| Variables | Case 1a | Case 1b | Case 2a | Case 2b | Case 3 | Case 4 | Theory |
|---|---|---|---|---|---|---|---|
| Formaland informal regulation by hospitals | No | No | No | Existence of such policies in hospitals will make the staff feel much more comfortable and allow the staff to work without tension in hospital | Existence of formal and informal policies can help and facilitate the process of adoption. Policy can decrease or prohibit resistance to the technology and solve various privacy issues | No | Taking benefits from policies to address privacy issues, are necessary in healthcare domain Staff should be informed about when they will be monitored, who will have access to their data and how long the data will be kept before being terminated (Fisher and Monahan, 2007) |
| Government standard and regulation for privacy and security issue | No | No | No | No | No | No | The government needs to issue a number of policies to protect and promote the RFID application. Only in such an environment, firms can speed up the RFID application in the organizations (Yue *et al*., 2008) |

**Description and comparison privacy, ethical and security critical success factors:** Establishing formal and informal policies by hospitals have been mentioned by only two interviewees as critical success factor for RFID adoption. Comparing theory with respondents comments, reveal that respondents approximately have addressed what the theory has mentioned with less emphasis on privacy issues and more on better understanding the duties and responsibility of hospital staff and increasing their knowledge. It is assume that some of hospitals are consider existence of such formal and informal policy important for adoption, however; they are still not taking privacy and security issue as important as it should be in developed countries.

Government standards and regulation for privacy and security issues have not been defined by any of respondents as critical success factor for RFID adoption. Based on theory, the government needs to issue a number of policies to protect and promote the RFID application so that, firms can speed up the RFID application in the organizations (Yue *et al*., 2008). Iranian hospitals authoritie's response to this critical success factor, showed, they don't see existence of such policy as help or critical success factor to RFID adoption and based on their response regarding identifying privacy, ethical and security barriers in previous research question, they don't see these factors as determinant factors that affect their decision making regarding adoption of RFID. Furthermore, privacy issues raised by the technology are amongst the factors that slow down the adoption of RFID. The feeling of being watched by hospital administrators during break time and patient care have caused many nurse's unions to prevent the adoption of new technology. RFID systems cause a major ethical concern regarding privacy violations because of its surveillance potential. This might act as barrier to adoption of technology. Surveillance capability of RFID can put pressure on healthcare staff (Table 3).

## CONCLUSION

The purpose of the current study was to identify the determinants of RFID adoption intention in Iranian hospitals from the hospital's manager's and staff's perspectives on the relationship between these determinants and RFID adoption intention. The empirical results testing the relationships between the determinants and RFID adoption intention demonstrated that Organizational, Environmental and Technical have

positive effects on intention to adopt RFID technology, while security and privacy concerns have a significantly negative and direct effect on RFID adoption intention by hospitals in Iran. In addition, even though the Organizational relative advantage has no direct effect on adoption intention, it has an indirect effect on adoption intention through organizational usefulness. Furthermore, Environmental influence and security and privacy concerns are the factors that affect the intention of decision makers (top and mid managers) to adopt RFID technology inversely Technical organizational usefulness, Environmental influence and security and privacy concerns are the drivers of RFID adoption intention among RFID technology potential users in hospitals, namely healthcare and supporting staff.

As Iran's hospitals, especially the public ones, are highly dependent upon government support and as the application of RFID technology in Iran's healthcare industry is still in its initial stage, the Iranian government should provide financial incentives, pilot projects and design a RFID policy to stimulate RFID adoption in the healthcare industry. To increase the pace of adoption and to ensure a continued usage of the adopted technology, the government should communicate the advantages of RFID to hospitals properly and provide necessary support along the way. The willingness to adopt RFID technology will be reinforced for hospitals if the government can provide various support such as resources and continuous encouragement policies.

This study highlighted the role of security and privacy concerns concerning RFID adoption by hospitals. This result is consistent with many other previous studies like Vanany and Shaharoun (2008) and Yao *et al*. (2010). (45http://link.springer.com/article/10.1007/s10916-014-0172-4-CR57) since, they claimed that security and privacy threats are the factors that slow down the adoption of RFID. Hence, a holistic methodology to protect and manage security and privacy of RFID usage is required. The policies should explain why and how the data will be gathered, how long the data will remain in the systems, how and in what way the data will be used, how the security of personal data will be protected and who is in charge of the collected data. Only in such an environment, can hospitals speed up RFID adoption [46http://link.springer.com/article/10.1007/s10916-014-0172-4-CR60]. In addition, formal and informal policies regarding surveillance of staff should be established by hospitals. Establishing benefits from policies that address privacy issues are necessary in the healthcare domain [47http://link.springer.com/article/10.1007/s10916-014-0172-4 - CR59]. Staff should be informed about when they will be monitored, who will have access to their data and how long the data will be kept before being erased. Furthermore, to relieve anxiety of hospital staff and patients, it is important to tell them and help them understand the purpose of this data collection.

Finally, security and privacy concerns are drivers of intention to adopt RFID by users in hospitals (healthcare and supporting staff). These results suggest that in order to motivate hospital's managers to adopt RFID technology, the government needs to support the implementation of this technology by allocating budget and resources and issuing standards and policies that protect the security and privacy of stakeholders using the RFID technology.

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