جـــامـــعـــة زايـــد
ZAYED UNIVERSITY

Working Paper No. ZU-WP 2017-04-23

RFID adoption in healthcare organizations in UAE

Ahed Abugabah, PhD

Views presented in this working paper are those of the authors and do not necessarily represent views of Zayed University

Working paper

RFID adoption in healthcare organizations in UAE

Ahed Abugabah, *PhD*
College of Technological Innovation
Zayed University
Ahed.abugabah@zu.ac.ae

Abstract

Radio frequency identification (RFID) is currently regarded as one of the most promising technologies, and considered as one of the sixteen key technologies in the coming decade, specifically in terms of its use, pervasiveness, market demand and commercial availability. RFID is perceived as critical technology for many purposes and applications, such as improving the efficiency and effectiveness in business operations and improving customer service. This research therefore has a hedonic motivation in developing an incorporated view of theoretical framework to identify factors that affect RFID adoption in healthcare and providing an empirical analysis of the effect of both organizational and individual factors on the diffusion of RFID based on the health care industry. Unlike other studies, the current study places more attention on individual factors in addition to the organizational factors and technological factors in an attempt to better understand the phenomenon of RFID adoption in health care, which is described as a complex and a very demanding work environment. This study serves to fill a gap in the existing literature through explaining of how user factors can contribute to the adoption of RFID in healthcare and how such factors might lead to better understanding of the benefits, use and impacts of RFID in health care sector.

Keywords**:** *RFID, health care, IT adoption and user factors*

1. Background

Radio frequency identification (RFID) is currently regarded as one of the most promising technologies, and considered as one of the sixteen key technologies in the coming decade, specifically in terms of its use, pervasiveness, market demand and commercial availability. RFID is perceived as critical technology for many purposes and applications, such as improving the efficiency and effectiveness in business operations and improving customer service. In today's business environment, all of these advantages would dramatically affect a

business operation through the improvement of efficiency and effectiveness as well as providing better service to customers (Ahmadi et al, 2017; Adhiarna, Hwang, Park and Rho, 2013).

An RFID is a generic term refers to the use of waves and radio frequency wireless communications to transmit, label and automatically identify people or objects (Sharma, Citurs, & Konsynski, 2007). An RFID system will usually have three components: tags, readers, and middleware. RFID's role is to support data processing of business activities, and it is always connected to an enterprise application system (Chong and Chan, 2012). RFID has become so popular nowadays that we are ''witnessing the forward progress of an unstoppable technology adoption and has huge impact on various industries. This consequently led to high interest in this technology by both academics and practitioners recently, although RFID was developed in the early 1970s. Another reason for the recent interest besides its popularity, is the decreasing costs of RFID and its potential in different operational settings, such as logistics and supply chains, manufacturing, automobile and food safety management and in particular health care industry (Sharma et al., 2007).

Health care is a significant growing sector for RFID applications with a global market of $2.03 billion by 2018 (Cao, Jones and Sheng, 2014; Zhou and Piramuthu, 2010). Based on Institute of Medicine (IOM) and National Coalition of Healthcare (NCHC) reports, U.S. health care expenditures in 2009 alone cost $810 billion, consisting primarily of overuse, underuse, and waste. Health- care costs are reported to increase drastically since 1970 and is estimated to increase to $4.4 trillion by 2018, and account for 20% of GDP (Yazici 2014). The rising cost of healthcare is a worldwide ongoing problem as several countries reported challenges in providing healthcare services (Fosso Wamba, Anand & Carter, 2013).

Despite the fact that RFID has been applied in many industries, academic researches on RFID in the healthcare remain sparse. This is surprising given that Healthcare's operations management has significant impact on its performances. Challenges faced by healthcare organizations include having insufficient and inaccurate pharmaceutical inventory control and operations, lack of patient identification, inability to accurately track patient locations, giving wrong medications to patients, and inability to track equipment such as surgical equipment, beds and wheelchairs, all could be resolved by RFID use (Chong and Chan, 2012). Empirical research indicated that the number of preventable patient safety incidents and/or medical errors such as mislabeled blood sample, wrong drug item and/or quantity and transfusion using the

wrong blood bag among others, is on the rise as budget cuts in health care institutions and pharmaceutical industry translate to related adverse effects. Besides the rapidly growing health care needs with increasing life expectancy and rising healthcare cost, healthcare organizations face ever increasing challenges such as maintaining continuous service with an augmented pressure to deliver high quality patient care, work and environment requirements, shortage of medical staff and increasing medical errors ((Yazici 2014; Reyes et al., 2012).

RFID tags are touted to be primary contenders among the technologies used to address these issues (Zhou and Piramuthu, 2010), and help healthcare organizations overcome most of its current challenges, and improve performance efficiency (Lapointe, Mignerat, et al., 2011), and quality of health care services (Mehrjerdi, 2010 Fosso Wamba, Anand & Carter, 2013; Chong and Chan, 2012; Yazici 2014). For example, to ensure the safety of medical staff by identifying and tracing possibly infected individuals through the use of RFID (Vanany and Shaharoun, 2008). Ngai et al. (2009) designed a RFID-based healthcare management system using an information system design theory approach. The results showed that their prototype was able to improve patient safety, improve pharmaceutical operations and use of medication and improve in-hospital location tracking as well as patients' identification. Others noted that by the use of electronic systems alone, US healthcare organizations can improve efficiency which might lead to potential savings of about $142–371 billion (Ahmadi et al, 2017; Adhiarna, Hwang, Park and Rho, 2013). Yazici (2014) showed the potential of RFID and mobile technology for healthcare in many areas such as tracking hospital assets and supplies, patient monitoring, error prevention, medicines tracking and staff communication

Despite the promising trends and potential outcomes, health care organizations have not fully embraced and/or recognized the RFID technologies, and in many cases health care practitioners are unable to justify their large investment on such technology. For example, a report of the American Hospital Association (AHA) stated that 55% of 795 hospitals nation- wide surveyed were subject to Medicare penalties in 2015 due to the inability to comply with proposed requirements by AHA. The hospitals surveyed expected to incur penalties ranging between $200 million and $1.1 billion through 2019 (Yazici 2014). Carr et 1., (2010) indicated that, despite the promise of RFID technology in the literature, healthcare organizations are still in the early stages of admitting this technology. As indicated by several researchers, the benefits of auto identification systems including both tangible and intangible pay-offs and possible application mechanisms are generally not widely known or not justifiable (Matta, Koonce, &

Jeyaraj, 2012). Yao, Chu and Li (2012) pointed to the scarcity of RFID adoption in healthcare and lack of publications and empirical studies that examine the adoption of RFID in healthcare as compared to those in other settings such as manufacturing, and logistics and supply chain (Chong and Chan, 2012).

Researchers suggest that the decision taken in the adoption of information technology in healthcare, has a complex nature and involves multiple stakeholders. Additionally, rather than being dependent solely on the characteristics of the technology and environmental influences (Currie, 2012; Sherer et al., 2016). Many IT innovations in organizations involve a two-part multi-level adoption decision process including formal decision and a local adoption. A formal decision is usually made by key decision makers to adopt and acquire that innovation and make it available to the organization. The local adoption decision is usually followed, which is made by the intended users such as physicians and medical professionals about whether to actually use the innovation, and how (Adhiarna et al., 2013). The second part seems to be as important as the first on, because it brings the pay back and benefits gained by such decisions by both parts.

Unfortunately, based on the literature review conducted, and described below, user factors have deemed to be critical aspects that did not receive enough attention by prior research. In many studies there has been an omission and/or overlooked of user factors. Majority of previous studies focused on organizational and environment factors to help organizations justify their large financial investments and quantify performance outcomes gained. This research therefore has a hedonic motivation in developing an incorporated view of theoretical framework to identify factors that affect RFID adoption in healthcare and providing an empirical analysis of the effect of both organizational and individual factors on the diffusion of RFID based on the health care industry. Unlike other studies, the current study will place more attention on individual in addition to the organizational factors in an attempt to better understand the phenomenon of RFID adoption in health care, which is described in previous research (Venkatesh, Sykes and Zhang 2011) as a complex and a very demanding work environment. This study serves to fill a gap in the existing literature through explaining of how user factors can contribute to the adoption of RFID in healthcare and how such factors might lead to better understanding of the benefits, use and impacts of RFID in health sector.

2. Purpose of the study

The purpose of this project is to provide a framework for radio frequency identification (RFID) technology adoption in UAE hospitals considering several factors and dimensions including: RFID adoption and implementation, expected benefits, barriers and obstacles that might exist preventing these hospitals from gaining valuable benefits of such a technology. Therefore, the project will address the following issues:

1. Identify to what extent RFID technology is/will be adopted in healthcare organizations
2. Provide a framework to hospitals of RFID and its implementation
3. Identify possible adoption and implementation factors at both organization and user levels

3. Literature Review

Researchers in the past examined the adoption of IT in the healthcare industry (i.e. Venkatesh, Sykes and Zhang 2011; Chong and Chan, 2012; Carr, Zhang, Klopping, and Min, 2010; Matta, Koonce and Jeyaraj, 2012; Yao, Chu, and Li, 2012; Ting, Kwok, Tsang, and Lee, 2011). However, majority of these studies focused at the macro level such as the industry's business environment and at the level of hospitals. Particularly, most RFID adoption studies in the healthcare industry are based on organizational level omitting therefore the individual level and user factors (Lee and Shim, 2007; Chong and Chan, 2012; Ngai et al. 2009). For example, Reyes et al. (2012) examined the antecedents of RFID implementation in healthcare by examining 88 healthcare organizations integrating only organizational and environmental factors. Schmitt et al. (2007) conducted a literature review on RFID adoption and derived 25 adoption factors from the technological, organizational, and environmental dimensions. They also extracted the five most important factors affecting the RFID adoption and diffusion cited in previous studies, including compatibility, costs, complexity, performance, and top management support, as well as technological characteristics. Lee and Shim (2007) developed a model to predict healthcare organizations' intention to adopt RFID and found that perceived benefits, market uncertainty and vendor pressures have a positive influence on healthcare organizations' likelihood to adopt RFID. Neeley (2006) proposed a model integrating both organizational and inter- organizational factors, and technological factors to directly impact RFID Adoption in organizations. His results showed that both organizational size and perceived benefits had a significant impact on RFID Adoption. Lee and Shim (2007) extended the concept of technology-push/need-pull to investigate the likelihood of adopting RFID within the healthcare industry and reported that organizational readiness moderated the relationships

between technology push, need-pull, and the presence of champions, and the likelihood of adopting RFID. Wamba et al. (2009) empirically evaluated the factors that matter most and least to organizations when adopting RFID. The results indicated that perceived benefits and management commitment mattered most to adopting organizations, whereas security and privacy threats mattered least when making the RFID investment decision. More recently, Chong and Chan (2012) examined the diffusion decisions of hospitals and clinics by using a framework integrating technological, organizational, environmental factors. The results indicated that the diffusion of RFID in hospitals is influenced by several factors such as its relative advantage, security cost, competitive pressure and management support.

Prior research on RFID adoption in healthcare has revealed positive signs of research and advancement in the study of RFID (Ngai et al. 2009). However, studies on the RFID adoption decisions of individuals such as physicians, medical staff and nurses remain omitted (Chong, Liu, Luo and Boon, 2015). Only few empirical studies have been found to investigate user aspects of RFID adoption either partially or as one factor among many organizational factors with a clear emphasis on organizational factors that affect the decision toward RFID adoption (Kim and Garrison, 2010; Chong, Liu, Luo and Boon, 2015). Organizations' decision to adopt RFID does not guarantee a successful deployment of the system in the long term (Chong and Chan, 2012). In order to have RFID deployed successfully, it is important to examine stakeholders point of views and evaluations such as doctors, physicians and nurses' decisions in adopting RFID technology.

Furthermore, despite the fact that the investments on RFID usually come from an organization's decision, there is a basic concept underlying the user adoption of IT places strong emphasis on an individual's reactions to IT (Chong et al., 2015). The firm level benefits can only be achieved when individual users in important roles in healthcare organizations such as physicians, medical operations managers and nurses embrace and use the system (Venkatesh, Sykes and Zhang 2011). If these stakeholders for example, physicians and nurses resist the use of RFID, it will be difficult for RFID to be successfully implemented in hospitals. Furthermore, healthcare professionals frequently face the dilemma of being introduced to a new technology but with little or inadequate training and user support (Venkatesh et al., 2011). As a consequence, adoptions of technologies tend to take longer than expected in the healthcare industry when compared to other industries. Many healthcare administrators and physicians are still relying on paper records that may not contain the latest information or may have higher

risk of errors resulting from manual inputs. This undoubtedly led to unrecognized benefits and/or reluctant of further implementation decisions and development of RFID technology by top management. In saying this, prior IT research that investigated different IT applications in healthcare sector found that user factors are crucial determinants of technology adoption and deployment. Such factors include user evaluation and perceived benefits, user believes, IT skills, technology awareness, perceived usefulness and ease of use, are all proven to be important factors determining the intension to use a new system and the level of usage of new technology.

4. RFID technology adoption in healthcare

Adoption of innovations is a research topic of enduring interest to IT researchers. Various models have been developed to understand and predict adoption of innovations and to identify adoption drivers of innovations by both individuals and organizations. IT field has witnessed many theories and models that are applied to investigate variety of IT issues including adoption and utilization aspects. Namely, Diffusion of innovations (DOI), Technology-Organization-Environment framework (TOE), Technology acceptance Model (TAM), Theory of Reasoned Action (TRA), and the United Theory of Acceptance and Use of Technology.

Similar to innovations, RFID technology adoption progresses over time and in several stages, including initiation, experimentation and implementation (Matta et al. 2012; Yazici, 2014; Reyes et al., 2012). Accordingly, researchers examined the critical factors of RFID technology adoption issues and the reasons beyond the slow adoption rate using innovation frameworks and theories. Among these theories, both the theory of DOI and the TOE have been the primary theory utilized by researchers for grounding RFID adoption research as they have been found to assist researchers in predicting the factors that lead to the adoption and use of various technologies. As a consequence, existing studies on RFID have been dominated by organizational, behavioral, and information system perspectives, with only limited conceptual and empirical studies have been undertaken.

Beyond the well-developed theory of DOI and TEO, much of the literature discusses adoption and diffusion for different IT cases come from different perspectives including the country level (Adhiarna et al., 2013), the industry level (Adhiarna, Hwang, & Rho, 2011) to the organization level (Yazici, 2014), but organization perspectives have received the most attention in the literature (Matta et al. 2012; Yao et al., 2012; Van der Togt et al., 2011). Studies of IT adoption at the country level are generally characterized by diverse research goals and

topics, with a strong focus on main IT infrastructure aspects and IT investment, which resulted in various assessments and different research outcomes (Maugis et al., 2005). Similarly, studies on the industry level had a very narrow focus and discussed RFID adoption without providing clear results of the factors leading to the adoption decision. This might be because the framework was adapted from the organization perspective such as (Schmitt and Michahelles, 2009)

Although RFID has the potential to play critical roles in delivering efficient and effective healthcare, the investment and adoption in information technology such as RFID by the healthcare industry has remained low when compared to other industries (Chong and Chan, 2012; Devaraj et al., 2013;). Many practitioners are aware of the potential benefits of RFID, many are unable to justify their large investment on such technology. Therefore, the principle tenets of DOI and TOE may not hold with respect to RFID Adoption. There is no better anecdotal evidence to suggest a reluctance to embrace RFID than the unwillingness by some of Wal-Mart's suppliers to adopt RFID despite the retailing giant's RFID mandate. This suggests that many organizations are reluctant to adopt RFID despite recognizing the technology's perceived benefits; and that there are other attributes associated with an organizations decision to adopt RFID. This highlights the need to incorporate other factors to the framework used in previous research, and not only limiting the focus on organizational factors and benefits perceived at the organizations level (Kima and Garrison, 2010).

In addition to DOI and TOE models, researchers took advantage of Human-Organization-Technology fit model to conduct rigorous evaluation research on IT applications adoption in healthcare contexts (Lian, Yen, & Wang, 2014; Yusof, Kuljis, Papazafeiropoulou, & Stergioulas, 2008; (Yao et al., 2012; Matta et al.,2012; Carr et al., 2010; Ting et al., 2011). Yusof et al. (2008) provided a comprehensive, specific evaluation factors, dimensions and measures (HOT-fit model) which are suggested to be applicable in IT adoption evaluation study. According to the HOT-fit model, human factor is central to the evaluation of IT applications adoption and development in healthcare. Literature on healthcare IT overlooked this concept in explaining the role of human context in behavior of hospital setting towards IT adoption (Lian et al., 2014). According to many researchers such factors engaged in the human context need to be considered when adopting and implementing any technology innovation within the context of the healthcare industry (Ahmadi et al. (2017; Yusof et al. 2008). In other words, there is a strong belief among researchers in IT adoption in general and healthcare in

particular of the importance of human factors when adopting and evaluating IT applications. In this sense, prior research noticed a great overlap in this HOT-fit model with the TOE framework. However, they also indicated that the HOT-fit model does not take into account the environmental context. On the other hand, the TOE framework does not explicitly have a category of human factors. Therefore, each one is telling a part of the story. Incorporating these two models along with DOI dimensions seem to be appropriate and will provide a more inclusive framework. In this sense Yusof et al, (2008) suggest that the more fit between technology, human, and organization, the more potential of the health IT can be realized. Hence, these factors can form a comprehensive, specific evaluation framework applicable in evaluating the adoption of RFID technology in healthcare.

Drawing from the literature on IT and RFID adoption combined with the theoretical perspectives discussed in previous section, the current study combined an integrated model of DOI and TOE and borrowed the idea of HOT-fit model with an addition of user factors that were believed in the literature as critical for the adoption decision RFID. This will help build a proper theoretical foundation to better understanding the determinant factors of RFID adoption in healthcare. The current model seems to be more inclusive incorporating more factors that are deemed to be critical when adopting new technology. We conjecture that incorporating human "user" factors to these models will yield rigorous explanation on how individuals and organizational factors contribute together and individually to the decision of RFID adoption. This also will help understand how an RFID use will yield benefits and impacts on performance and healthcare services perceived by individuals, which might help organizations and management to justify large investments on such a technology. The current model holds much promises to shift the focus of researchers on other factors when evaluating RFID payback and benefits.

5. Research model and framework

5.1. Framework

Existing RFID literature provides the foundation for developing the research framework by identifying factors that are deemed to be crucial for RFID adoption. The current research framework is formulated through the results of an extensive view and theoretical examination of the related existing literature on IT adoption in healthcare in general and RFID research in particular. The researcher used most frequent dimensional factors from the established

adoption theoretical-studies and when needed the items used were tailored to suite RFID context in this study as listed in Table 1. The framework is incorporating three different models including the TOE, DOI and HOT-fit model. The factors of and the barriers to RFID adoption are categorized into five main dimensions which are technology, organization, environment and economy and human (user) factors. It is believed that the five aforesaid dimensions are well suited in this study for studying the RFID adoption by health care organizations in UAE.

5.1.1. Technological factors

Technological factors including complexity, compatibility, relative advantage, compatibility and privacy and security, and maturity of technology were main dimensions frequently cited in many prior IT innovation studies as determinants affecting the decision of the organizational adoption of new technology (Ahmadi et al., 2017). In this sense, Davenport and Brooks (2004) described uncertainties about the compatibility of RFID with other systems (including enterprise resource planning [ERP] systems) as a potential obstacle. RFID is a complex set of considerations, with different operating systems, middleware, hardware, languages, and architectural structures (Gessner, Volonino et al. 2007). These factors are compounded by the fact that RFID networks require globally synchronized numbering, frequency and power standards. Research ranks standards as the number one challenge from a list of twelve issues shaping the future of RFID (Viehland and Wong, 2007). RFID requires several important network and infrastructure standards to work effectively (Rahman, Yang and Waters, 2013). Based on the above discussion, it is hypothesized that technological factors will affect the adoption decision of RFID in health care organizations

5.1.2. Organizational factors

Organizational factors are the most widely studied variables in IT adoption researches and have been described by many researchers as important factors influencing the technological innovation adoption in organizations Ahmadi et al., 2015; Chang et al., 2006, 2007; Lin et al., 2012). Tornatzky et al., (1990) in their original TOE model suggested three main variables that affect the adoption of technological innovation with regard to organizational dimension. Researchers cited organizational size and top management support as main factors affecting the adoption of information technology. Others included financial resources as main factor determining the organizational decision to adopt a new technology. Within an RFID context however, prior research suggested that RFID technologies are expensive and, hence, could be more applicable for large organizations than small size organizations, with the requisite

resources (Lin and Ho, 2009). Similarly, larger organizations should choose to take risky innovations to remain competitive in today's business environment. Top management commitment and commitment to IT initiatives were also cited as critical and essential factors for the adoption of RFID technology (Attaran, 2007).

In recent literature five commonly and frequently recognized characteristic features of organizational dimensions seem to positively influence the organizational adoption process and decision (Ahmadi et al., 2015; Chang et al., 2006, 2007; Lin et al., 2012). These include top management support, organization size, and financial resources, IT infrastructure. Hence, it is hypothesized that organizational factors affect the adoption decision of RFID in health care organizations in UAE.

5.1.3. Environmental factors

Previous studies mentioned various environmental factors which affect decisions and intensions to adopt RFID adoption in different industries. These include industry pressure, competitive pressure, trading partner, partner power and expectation of market trends (Sharma and Citurs, 2007; Wu and Subramaniam, 2009; Schmitt and Michahelles, 2009). For example, Walmart's mandate all suppliers to use RFID systems in all products, and suppliers' awareness of the consequences of not complying resulted in the adoption of the technology in all products they provide. The competitive pressure faced by the health care industry has driven many organizations to adopt RFID in order to achieve better operation efficiency, more accurate data and better inventory and supply chain visibility. This signify the industry pressures on adoption and actual use of RFID. Therefore, this research hypothesized that environmental factors will affect the adoption decision of RFID in health care organizations

5.1.4. Economic factors

Economic factors including technology cost, training and maintenance costs have been described as an important and critical issue affecting RFID adoption (Viehland and Wong, 2007). Researchers believed that extensive use of RFID would not be possible unless RFID costs reduce drastically (Attaran, 2007). More importantly, RFID infrastructure costs influence the adoption intentions of RFID, specially with the dramatic changes of infrastructure costs. Lastly, other costs such as training and maintenance costs are often unknown and may at times be greater than the expenses on technology. In healthcare setting, researchers indicated that these costs of IT project implementation count for almost 70% of project implementation.

These economic factors impact adversely on RFID adoption in compression to other relatively cheap alternative options such as barcode technology. Hence, it is hypothesized that economy factors affect RFID adoption in healthcare organizations in UAE

5.1.5. Human Factors

The success and improvement of health care technology in the hospitals is guaranteed by the end-users' enthusiasm to support the changes, and adoption. Hakim, Renouf, & Enderle, 2006) and has a return on investment (Glabman, 2004). Researchers indicated that healthcare and supporting staff's adoption of a technology is dependent on whether that new technology can facilitate their medical duties (Yu, Ray, & Motoc, 2008) and aid to ease the use (Aggelidis & Chatzoglou, 2009. Human factors including IT competences and individual IT skills, training and user support and resistance to change were cited as crucial factors to IT adoption in health care. For example, IT Employee's skills have been identified that affects the organizational adoption of IS innovation (Anand & Kulshreshtha, 2007; Lee & Kim, 2007; Hong & Zhu, 2006; Lian et al., 2014; Thong, 1999; Zhu et al., 2003). In a hospital's environment, staffs' technological capabilities and/or competencies has a crucial role when a hospital is adopting an innovative IT (Lin et al., 2012; Liu, 2011). Another factor which was described as one of the key barriers to successful adoption and implementation of healthcare IT is the lack of adequate training and support to the users. Many healthcare professionals are often faced with the dilemma of being introduced a new technology but with little training and process change support (Venkatesh et al., 2011). Therefore, it is hypothesizing that human factors will affect the decision adoption of RFID in health care organizations in UAE.

Table 1. Summary of previous RFID adoption studies and their frameworks in health care

Sharma, Thomas, & Konsynski,. (2008).	Organization: organizational readiness, availability of financial and technological resources (people, technology, expertise), and top management support Environment: Governmental influences, technology standards, legal environment, privacy concerns, and technological breakthroughs
Hossain & Quaddus (2009)	Organization: location, industry type, organizational readiness and organizational networks Environment: government policies, and market control factors.
Alqahtani, & Wamba (2012)	Organization: technology competence, top management support, and organization size. Environment: Information intensity, competitive pressure, government regulation and social issues.
Paydar & Endut, (2013).	Organization: organizational readiness, management support, human capital, organization knowledge, and organization size

	Environment: Availability, social issue, external support, competitive pressure, and trading partner Technology: Relative advantages, costs, return on investment, compatibility, and complexity
Wang, Li Zhang & Li, (2010).	Organization: top management support, IT expertise, organization size, information management level, and organization readiness. Environment: Competitors, government, customers, and RFID companies. Technology: Relative advantage, compatibility, complexity, and cost.
Tsai, Lai & Hsu (2012).	Organization: organizational readiness and sufficient organizational resources Environment: three institutional isomorphic forces may be involved: coercive, mimetic, and normative factors
Cobos, Mejia, Ozturk & Wang, (2016)	Organization: organizational size, organizational structure, employee technology expertise, communication patterns, and resource allocation. Environment: competition, customer, and governmental pressures. Technology: complexity, relative advantage, and compatibility
Cao, Jones & Sheng, (2014)	Organization: organizational innovativeness, organizational culture, organizational structure, and scope of the project. Environment: competitive pressure and competitive advantages Technology: expected benefits, process compatibility, standards uncertainty and technology readiness
Tsai, Lee & Wu, (2010)	Organization: organizational readiness and top management support
Rahman, Yang & Waters, (2013)	Organization: organizational size, top management support, and technological readiness Environment: industry pressure, security and privacy Technology: compatibility and complexity
Bunduchi, Weisshaar & Smart, (2011)	Economic factors: development costs, switching costs, compatibility costs and capital cost
Kim & Garrison, (2010).	Organization: organizational readiness: financial resources and technological knowledge
Nilashi, Ahmadi, Ahani, Ravangard & Ibrahim (2016)	Organization: presence of champions, IS infrastructure, top management support, hospital size and financial resources. Environment: pressures from the organization's external environment (competitors, and government policy and vendors Technology: relative advantage, compatibility, complexity, and data security.
Maduku, Mpinganjira & Duh, (2016)	Organization: firm's size, degree of centralization, degree of formalization, and managerial structure Environment: structure of the industry, the availability or non-availability of technology service providers, and the organization's regulatory environment Technology: internal and external technologies
Wang, Wang & Yang, (2010)	Organization: top management support, firm size and technology competence Environment: competitive pressure, trading partner pressure and information intensity Technology: Relative advantage, complexity, compatibility
Adhiarna, Hwang, Park & Rho, (2013).	Organization: management systems, financial resources, and organization competence Environment: macro-economic conditions, regulations, and industry characteristics. Technology: IT infrastructures, IT supports, and standards. Human (user): skills, education, and attitude toward RFID and IT.

Lu, Lin, & Tzeng, (2013)	Organization: top management support, firm size and organizational readiness Environment: competitive pressure, partner readiness and regulatory support Technology: technology integration, technology competence and security concern Economic: Hardware cost, software cost, implement cost and maintenance cost
Weerd, Mangula & Brinkkemper, (2016)	Organization: top management support, organizational readiness, organizational size, innovativeness, prior IT experience, and information intensity. Environment: external pressure, competition intensity, and government support. Technology: existing technologies in use and the emerging technologies
Faber, Geenhuizen & Reuver, (2017)	Organization: size of the hospital, top management support, organizational readiness, centralization in decision-making, and absorptive capacity adoption in hospitals
Sharma et al. (2007)	Organization: management support, IS infrastructure and capabilities, and financial readiness Environment: perceived standard convergence and perceived privacy Technology: compatibility and expected benefits
Schmitt and Michahelles RFID (2009)	Technology: Complexity, compatibility, cost, perceived benefits Organization: Size, top management support, presence of a champion, technical know-how, resistance of the employees
Wu and Subramaniam (2009)	Technology: complexity, compatibility and maturity of technology, advantage Organization: financial resources, top management support and IT sophistication Environment: competitive pressure, trading partner, partner power, and external support
Wang et al. (2010)	Technology: relative advantage, complexity and compatibility Organization: management support, firm size and technology competence Environment: competitive pressure, trading partner pressure and information intensity
Li et al. (2010)	Technology: complexity, compatibility, cost and advantage Organization: size, top management support, and IT units staffs Environment: customer, vendor, competitor and government
Chong and Chan, 2012	Technological factors: relative advantage, compatibility, complexity, cost, security Organizational factors: organization size, top management, financial resources, and technological knowledge Environmental factors: expectation of market trends and competitive pressure
Adhiarna, Hwang, Park, and Rho, 2013)	Organization, people, environment, strategy and technology
Paydar and Endut, 2013	Technological factors: relative advantage, compatibility, complexity, cost and return on investment Organizational factors: organizational readiness, management support, organization size, human capital, organizational knowledge Environmental factors: availability, social issues, competitive pressure, external support and trading partner

5.2. Research model and hypotheses

Based on the current literature in this study and on the framework discussion in previous section the following hypothesis were tested in this study, as illustrated in Figure 1.

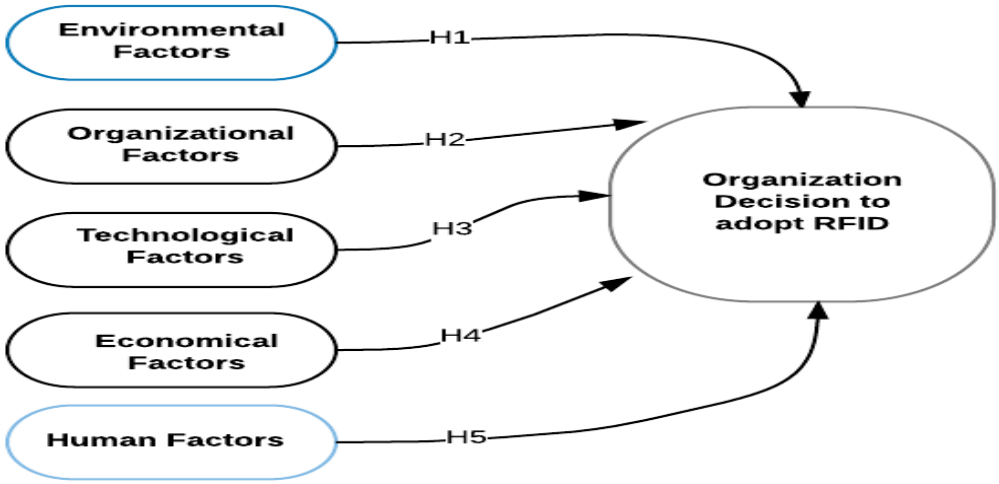

Fig. 1, Research Model

H1: Environmental factors have a positive effect on the adoption decision of RFID in health care

H2: Organizational factors have a positive effect on the adoption decision of RFID in health care

H3: Technological factors have a positive effect on the adoption decision of RFID in health care

H4: Economical factors have a positive effect on the adoption decision of RFID in health care

H5: Human factors have a positive effect on the adoption decision of RFID in health care

6. Research methodology

This section outlines the details of the research methodology employed to develop a framework of RFID adoption in health care organizations. This is a core goal of the current study to be used for increasing the level of adoption in the context of UAE hospitals. This study is explanatory in nature and aims to explain and predict the expected relationship between the defined independent variables and an observed dependent variable through empirical testing of suitable incorporated theories.

A survey instrument was developed to gather data from health care organizations and test the hypotheses proposed in this research. The instrument used mainly existing measures to

operationalize the constructs because the current literature review showed that well-established measures existed for all constructs, with a need to amend some items to be tailored to the RFID context. The survey has two sections, the first one has information about users and their demographics, while the the second section has questions measuring the study constructs. A five-point Likert scale was used, ranging from 1 – strongly disagree to 5 – strongly agree, which seems to be suitable for this kind of research and used in many similar studies.

Prior to data collection, hospitals were contacted by email to explain the aim of the study and to solicit their cooperation. The study was conducted in 6 government hospitals in UAE. A contact person was assigned in each hospital to facilitate data collection. Before the data collection process started, the survey had been reviewed with five employees and two managers to ensure that the wordings and formats were appropriate for the health care industry. Only few minor changes were made accordingly. The survey was then sent by email to the contact person in order to be distributed to all employees and professional staff in the hospitals. In total, 207 surveys were returned to the researcher either by email or to the contact person. Data control and filter was performed to ensure completeness and suitability of the questioners returned. Out of these 191 retuned questionnaires, 9 were eliminated for incompleteness and 182 questioners were used in the data analysis and the results reported in this study, as shown in table 2.

Table 2. Characteristics of the study ample (N=182).

Factor	Classification	Frequency	Percentage
Gender	Male	110	60.4%
	Female	72	39.6%
Education	Vocational	9	5%
	Bachelor	156	85.7%
	Postgraduate	17	9.3%
Work Type	Medical/Doctor	97	53.3%
	Nursing and LAB staff	57	31.3%
	Administrative	21	11.5%
	Others	7	3.9%
Experience	1-3 years	53	29.1%
	4-6 years	115	63.2%
	7-10 years	14	7.7%

7. Analysis and Findings

Reliability and validity measures

Both reliability and validity of the study instrument were assessed. Reliability was examined through the determination of Cronbach's coefficient alpha (β). An alpha value is considered satisfactory if it exceeds 0.70 according to (Tabachnick and Fidell, 2007; Hair, Hult, Ringle and Sarstedt, 2013). The results reported in Table 3, indicated the presence of satisfactory Cronbach alpha scores, which ranged from 0.81 for the technological factors to 0.91 for the economical factors, demonstrating thus high construct reliability (Tabachnick and Fidell, 2007).

Validity was measured using both discriminant and convergent validity tests (Tabachnick and Fidell, 2007). Discriminant validity can be assessed using the square root of the Average Variance Extracted (AVE) for each factor; the factors are different if the AVE for the factors is greater than their shared variance (Tabachnick and Fidell, 2007). As shown in Table 3, the diagonal values in parentheses represent the square root of the AVE. All AVE values are greater than the off-diagonal values (shared variance) in the corresponding rows and columns. Convergent validity was examined by three criteria: all item loadings are significant; composite reliability more than 0.70, while the AVE scores of all factors must exceed the threshold value of 0.50, as suggested by (Hair et al., 2013; Tabachnick and Fidell, 2007). All factor loadings for this study exceeded the recommended value of 0.70, and the AVE values ranged from 0.78 to 0.90, indicating that convergent validity was satisfied (Tabachnick and Fidell, 2007; Yusof, Kuljis, Papazafeiropoulou and Stergioulas, 2008).

Table 3. Correlations and Average Variance Extracted of the study constructs

Factors	AVE	1	2	3	4	5	6	Alphaα
1. Environment Factors	0.89	(0.94)						0.86
2. Organizational Factors	0.83	0.77	(0.89)					0.84
3. Technological Factors	0.87	0.64	0.58	(0.92)				0.81
4. Economical Factors	0.78	0.58	0.56	0.67	(0.87)			0.91

5. Human Factors	0.90	0.66	0.49	0.56	0.52	(0.95		0.87
6. Adoption Decision	0.89	0.53	0.39	0.47	0.39	0.45	(0.93)	0.83

7.1. Tests of the Measurement Model

The structural model is applied to examine the hypotheses proposed in this research. Researchers recommend the structural model as it is able to examine the direction and strengths of the relationships of the latent variables (Chong and Chan, 2012). Before testing the hypotheses in an appropriate model, we checked the goodness of fit of the research model. The fit between the data and proposed measurement model was measured using a chi-square Goodness-of-Fit Index model (GFI). Researchers often recommend a GFI index exceeding 0.80 and a cut-off criterion should be ≥ .90 for both indices of Normed Fit Index (NFI) and Incremental Fit Index (IFI) for acceptable model fitness. Researchers also recommend that fit values for the GFI should be greater than 0.90, where as the Adjusted GFI (AGFI) should be greater than 0.80 (). In general, if the value of χ^2/df is smaller than 5, it is considered a good fit. Conversely, it is generally reported in conjunction with the Root Mean Square Error of Approximation (RMSEA) and in a well-fitting model the lower limit is close to 0 while the upper limit should be less than 0.08t. All the goodness-of-fit measures fall into acceptable ranges, with scaled X^2 /df=1.60, CFI= 0.92, GFI=0.94, NFI=0.91, and RMSEA=0.083, as listed in Table 4. The Goodness-of-fit statistics indicated the overall structural model to be acceptable and hence the proposed combined model provided a good fit with the data.

Table 4. Goodness-of-Fit for the Measurement and Structural Models.

Criteria/Indices	Recommended Value	Measurement Model	Structural Model
Chi-square (χ2)	- - -	307.65	301.10
Degree of Freedom	- - -	190	195
χ2/df	>2	1.60	1.53
GFI	>0.90	0.94	0.93
NFI	>0.90	0.91	0.92
NNFI	>0.90	0.93	0.93
CFI	>0.90	0.92	0.92
RMSEA	>0.08	0.83	0.83

7.2. Tests of the Structural Model

The structural model was tested using a Structural Equation Modelling approach, and all relationships between the study contracts were tested using path coefficients and t-test analyses. The results of the structural model for measures of fitness are shown in Table 4 to facilitate comparison of the validity results. The goodness-of-fit indices for the structural model were X2/df=1.53, CFI=0.92, GFI=0.93, NFI=0.92, and RMSEA=0.83. Thus, the integrated model provided a good fit with the data in the RFID in health care. The results of the hypotheses test indicated that all hypotheses were supported. The paths between all of the factors were found to have significant and positive relationships. The hypotheses, path coefficients (β), and t-values for all factors are summarized in Table 4 P<0.05.

Table 5. Results of hypotheses tests

Hypothesis	Path Coefficient β	t-Value	Support
Environmental factors → RFID adoption	0.22	3.65	Yes
Organizational Factors → RFID adoption	0.33	4.48	Yes
Technological Factors→ RFID adoption	0.39	6.85	Yes
Economical Factors → RFID adoption	0.29	2.70	No
Human Factors → RFID adoption	0.37	5.09	Yes
Overall the study contracts → Adoption of RFID in health care	0.29	8.09	Yes

The findings indicated that the environmental, organizational, economical technological and human factors model significantly affects the decision to adopt RFID in healthcare (β=0.29, t=809). Technological factors were found to be the most significant among the study factors, affecting the decision to adopt RFID (β=0.39, t=6.85, p<0.05). Hence, H1 is supported. Environment factors also experienced a significant, but less effect on organizational decision toward adopting RFID (β=0.22, t=3.65). As expected, human factors were significant and play a crucial roles in affecting employees and decision maker to adopt RFID in their hospitals. The findings revealed a strong relationship between these factors and organizational decision to adopt RFID in health cate organizations (β=0.37, t=5.09).

8. Conclusion

While RFID has been considered an important technology that provides strategic and operational advantages for organizations, it has yet to see significant rates of adoption in the health care industry (Wang, Wang and Yang, 2010). Hence, it is necessary to understand what determines RFID adoption in the health care organizations. Based on previous IT theoretical adoption framework, the current study developed and validated a research model to examine the impacts of five main categories of factors consisting of environmental, organizational,

technological, economical and human contextual factors on RFID adoption in healthcare industry. The main contributions of this study are fivefold:

First, the study provides several key findings and implications about the determinants factors affecting the RFID adoption in a very complex sector described by previous researchers as a non routine and complicated business environment sector and has a unique business process and multidimensional and cross functional processes. Whether an organization implements RFID applications depends on the firm's environmental, organizational, technological and human contexts. Technological factor were found the most significant determinants of RFID adoption in health care. Among these determinants, IT infrastructure was observed to be the most influential factor affecting a hospitals' RFID adoption.

The study empirically confirms and supports the applicability of the integration of TOE, DOI and HOT-fir frameworks in understanding organization IT adoption (RFID). The synthesized framework provides a good starting point for analyzing and considering suitable factors that can affect organization innovation-adoption decisions.

Human resources are the most valuable asset of an organization that require a proper management to achieve substantial performance. According to the HOT-fit model, human factor is central to the evaluation of health information system adoption and development (Yusof et al., 2008). An organization that adopted an innovative technology successfully and gained benefits from it relied heavily on its staff having sufficient innovation knowledge or technology capability (Nilashi et al., 2016). According to Hung et al. (2010), the obstacle lack of skill and technical knowledge required in the development process, leads to delay in adopting innovation in organizations. Organizations tend to wait until they have sufficient technical expertise. Therefore, if employees have more knowledge of IT applications, most likely they will be able to adopt these applications (Hung et al., 2010). Hence, staff must have some knowledge of IT innovation in order to use more innovative IT. This was fond to be true in health care organizations as the results of the current study confirmed that human factor was a crucial factor ($\beta = 0.37$) influencing the firm's decision to adopt RFID applications in different organizational functions.

Finally, the findings showed that usability of RFID technology positively influences its adoption. This leads to another futuristic view of RFID that training firm's staff on RFID will improve the knowledge of user and hence can encourage the hospitals to adopt RFID in many functional areas. Future research can include user training and support as well as involvement to assess their effects on the adoption decision of RFID and how such factors can lead to more adoption rate of RFID in health care organizations

References

1. Attaran, M. (2007). RFID: an enabler of supply chain operations. *Supply Chain Management*, 12(4), 249-257.
2. Cao, Q., Jones, D and Sheng, H (2014). Contained nomadic information environments: Technology, organization, and environment influences on adoption of hospital RFID patient tracking. Information & Management, (51) 225-239

3. Carr, A. S., Zhang, M., Klopping, I., & Min, H. (2010). RFID technology: Implications for healthcare organizations. American Journal of Business, 25(2), 25–40.
4. Carr, A. S., Zhang, M., Klopping, I., & Min, H. (2010). RFID technology: Implications for healthcare organizations. American Journal of Business, 25(2), 25–40.
5. Chong, A and Chan, F (2012). Structural equation modeling for multi-stage analysis on Radio Frequency Identification (RFID) diffusion in the health care industry, Expert Systems with Applications (39)p 8645–8654
6. Chong, A., Liu, M., Luo, J and Boon, O (2015). Predicting RFID adoption in healthcare supply chain from the perspectives of users. International Journal of Production Economics, 159 (1)66-75
7. Currie, W. L., & Guah, M. W. (2007). Conflicting institutional logics: A national programme for IT in the organisational field of healthcare. Journal of Information Technology, 22(3), 235e247.

8. Davenport, T. H. and J. D. Brooks (2004). Enterprise Systems and The Supply Chain. *Journal of Enterprise Information Management*, 17(1), 8-19.
9. Devaraj, S., Ow, T.T., Kohli, R., 2013. Examining the impact of information technology on healthcare performance: a theory of swift and even flow (TSEF) perspective. J. Oper. Manage. 31 (4), 181–192.
10. Fosso Wamba, S., Anand, A., & Carter, L. (2013). A literature review of RFID-enabled healthcare applications and issues. International Journal of Information Management, 33(5), 875–891.

11. Gessner, G. L. Volonino, et al. (2007). One-Up, One-Back ERM in the Food Supply Chain. *Information systems Management* 24(3), 213-223.
12. Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., 2013. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Sage, Thousand Oaks.
13. Kim, S and Garrison, G, (2010). Understanding users' behaviors regarding supply chain technology: Determinants impacting the adoption and implementation of RFID technology in South Korea, International Journal of Information Management, 30, (5) 388-398
14. Lapointe, L., M. Mignerat, et al. (2011). "The IT productivity paradox in health: A stakeholder's perspective." International Journal of Medical Informatics 80(2): 102-115.
15. Lee, C., & Shim, J. (2007). An exploratory study of Radio Frequency Identification (RFID) adoption in the healthcare industry. European Journal of Information Sys- tems, 16(6), 712–724.

16. Li, J., Wang, Y. F., Zhang, Z. M., & Chu, C. H. (2010). Investigating acceptance of RFID in Chinese firms: The technology-organization-environment framework, pp. 263–268.
17. Lian, J.-W., Yen, D. C., & Wang, Y.-T. (2014). An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital. International Journal of Information Management, 34(1), 28e36.

18. Lin, C.-Y. and Y.-H. Ho (2009). RFID technology adoption and supply chain performance: An emprical study in China's logistics industry. *Supply Chain Management: An International Journal* 14(5), 369-378.
19. Matta, V., Koonce, D., & Jeyaraj, A. (2012). Initiation, experimentation, implementation of innovations: The case for radio frequency identification systems. International Journal of Information Management, 32(2), 164–174.
20. Matta, V., Koonce, D., & Jeyaraj, A. (2012). Initiation, experimentation, implementation of innovations: The case for radio frequency identification systems. International Journal of Information Management, 32(2), 164–174.
21. Mehrjerdi, Y. Z. (2010). RFID-enabled healthcare systems: Risk-benefit analysis. International Journal of Pharmaceutical and Healthcare Marketing, (4), 282–300.
22. Neeley, C. (2006). Connective technology adoption in the supply chain: The role of organizational, inter-organizational and technology-related factors. Unpublished Ph.D. dissertation, University of North Texas.

23. P. Schmitt, F. Thiesse, E. Fleisch, Adoption and diffusion of RFID technology in the automotive industry, in: H. Österle, J. Schelp, R. Winter (Eds.), Proceedings of the 15th European Conference on Information Systems, St Gallen, Switzerland, 2007.

24. Paydar, S and Endut, I, (2013), Key Drivers of RFID Adoption in M alaysian Retail Industry: A Theoretical Model, In the Proceeding of the 2013 IEEE International Conference on RFID Technologies and Applications, September, Johor Bahru, Malaysia
25. Rahman, S., Yang, L and Waters, S (2013). Factors Affecting RFID Adoption in Chinese Manufacturing Firms: An Investigation Using AHP, In the proceeding of the IFAC Conference on Manufacturing Modelling, Management, and Control International Federation of Automatic Control, Saint Petersburg, Russia
26. Reyes, P. M., Li, S., & Visich, J. K. (2011). Accessing antecedents and outcomes of RFID implementation in health care. International Journal of Production Economics, 136(1), 137–150.
27. Schmitt, P., & Michahelles, F. (2009). Status of RFID/EPC adoption. AutoID Labs.

28. Sharma, A., A. Citurs. (2007). Strategic and institutional perspectives in the adoption and early integration of radio frequency identification (RFID. Proceedings of the *40th Hawaii International Conference on System Sciences*, Hawaii.
29. Sharma, A., Citurs, A., & Konsynski, B. (2007). Strategic and institutional perspectives in the adoption and early integration of radio frequency identification (RFID), 224c.
30. Sharma, A., Thomas, D and Konsynski, B (2008). Strategic and Institutional Perspectives in the Evaluation, Adoption and Early Integration of Radio Frequency Identification (RFID): An Empirical Investigation of Current and Potential Adopters, In the proceeding of the the 41st Hawaii International Conference on System Sciences. Hawaii, USA.
31. Sherer, S. A., Meyerhoefer, C. D., & Peng, L. (2016). Applying institutional theory to

the adoption of electronic health records in the US. Information & Management, 53(5).

32. Shih, D. H., Y. W. Chiu (2008). An Empirical Study of Factors Affecting RFID's Adoption in Taiwan. *Journal of Global Information Management*, 16(2), 58-80.
33. Tabachnick, B., and Fidell, L., *Using Multivariate Statistics*, Allyn and Bacon, Boston, 2007.
34. Ting, S. L., Kwok, S. K., Tsang, A. H., & Lee, W. B. (2011). Critical elements and lessons learnt from the implementation of an RFID-enabled healthcare management system in a medical organization. Journal of Medical Systems, 35(3), 657–669.
35. Tsai, M., Lai, K and Hsu, W (2013). A study of the institutional forces influencing the adoption intention of RFID by suppliers, Information & Management (50) 59–65
36. van der Togt, R., Bakker, P. J., & Jaspers, M. W. (2011). A framework for performance and data quality assessment of radio frequency identification (RFID) systems in health care settings. Journal of Biomedical Informatics, 44(2), 372–383.
37. Venkatesh, V., Sykes, T.A., Zhang, X., 2011a. 'Just what the doctor ordered': a revised UTAUT for EMR system adoption and use by physicians. In: 2011 44th Hawaii International Conference on System Sciences (HICSS). IEEE, pp. 1-10.
38. Viehland, D. and A. Wong (2007). The Future of Radio Frequency Identification. *Journal of Theoretical and Applied Electronic Commerce Research*, 2(2), 74-82.
39. Wamba, S. F., Keating, B., Coltman, T., & Michael, K. (2009). RFID adoption issues: Analysis of organizational benefits and risks. Auto ID Labs. Available at: http://www.autoidlabs.org/uploads/media/RFID Investment Decison What Matters Most and Least.pdf.
40. Wang, Y. M., Wang, Y. S., & Yang, Y. F. (2010). Understanding the determinants of RFID adoption in the manufacturing industry. Technological Forecasting and Social Change, 77, 803–815.
41. Wu, X. & Subramaniam, C. (2009). New understanding of RFID adoption and infusion in retail supply chain, pp. 1–10.
42. Yao, W., Chu, C.-H., & Li, Z. (2012). The adoption and implementation of RFID technologies in healthcare: A literature review. Journal of Medical Systems, 36(6), 3507–3525.
43. Yusof M.M., Kuljis, J., Papazafeiropoulou, A., and Stergioulas, L.K., "An Evaluation Framework for Health Information Systems: Human, Organization and Technology-Fit Factors (HOT-fit)," *International Journal of Medical Informatics*, vol. 77, no. 6, pp. 386–398, 2008.
44. Yusof, M. M., Kuljis, J., Papazafeiropoulou, A., & Stergioulas, L. K. (2008). An evaluation framework for health information systems: Human, organization and technology-fit factors (HOT-fit). International journal of medical informatics, 77(6), 386e398.
45. Zhou, W and Piramuthu, S (2010)Framework, strategy and evaluation of health care processes with RFID. Decision Support Systems (50) 222–233