Chapter 17
Adoption of Internet of Things in Healthcare Organizations

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17.1 Introduction

The Internet of things is a new paradigm that enables integration and communication of things or objects such as radio-frequency identification (RFID) tags, sensors, actuators, mobile phones, etc. (Atzori et al. 2010). IoT devices are defined as cyber-physical devices which can operate in any context by its sensing, communicating, and processing capability (Cicibaş and Demir 2016). It is expected that IoT will provide novel solutions to transform the operation and role of industrial systems (Xu et al. 2014). In modern industry, these devices are being used for many purposes in terms of monitoring, tracking, data collection, and analyzing. Some preliminary IoT applications have been already implemented in several areas such as healthcare, public services, and automotive industries. Among these areas, the cost projection of IoT healthcare applications will be around 1 trillion dollars by 2025 (Manyika et al. 2015).

In healthcare perspective, IoT domain serves as a generic platform for exchanging information between mobile health (mHealth) devices and various ubiquitous technologies. IoT provides processing data which are collected by different types of devices such as mobile devices, implantable devices, wearable devices, and ambient-assisted living solutions. Therefore, IoT concept is a bridging architecture for mHealth technology through its IP-based connection capabilities.

The role of IoT in the mHealth domain can be explained by a simple example. By the aid of local area network communication technologies (e.g., Bluetooth, WI-FI, etc.), data which was collected by sensors deployed in patient's body are

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transmitted to the mobile devices (e.g., mobile phone, hub, etc.) of the patient. Then the mHealth application processes and send this data to a central database. By using another mHealth application, healthcare professionals access this database, diagnose, and may send instructions to the patient. In addition, this data is processed automatically by advanced tools to detect anomalies about the patients. IoT ensures communication and integration of these mHealth entities (sensors, devices, and applications) mentioned in this example. Regarding such a scenario, the impact of IoT concept on mHealth is crucial, and more effort is required to understand the relation between IoT and mHealth. We believe that effective use of mHealth technologies can be only achieved by using advanced IoT solutions. Successfully deployed and widely adopted IoT devices would increase the quality and amount of data which is considered as the main source of mHealth applications.

In literature, the impact of IoT on mHealth is investigated by several studies (Istepanian et al. 2011; Santos et al. 2014, 2016). These studies propose some theoretical models for integrating IoT capabilities into mHealth applications. The motivation of these works is nourished by the potential benefits of IoT capabilities which are expected to bring superior abilities to healthcare by enabling mHealth solutions. Existing studies have also proved this expectation by showing reduced costs and increased efficiency in IoT-enabled healthcare services (Couturier et al. 2012). In addition, IoT and its enabling technologies minimize healthcare failures such as medical mistakes, theft, loss, drug counterfeiting, and inefficient workflow (Yao et al. 2010). However, despite the increasing trend and its benefits, IoT devices are not fully integrated into healthcare organizations. One of the most important reasons for the lack of integration is the low adoption level of these technologies by the users. Regarding this open issue, more research is needed to investigate main variables that influence the decision to adopt these technologies.

Adoption of ICT systems in healthcare is examined in previous studies (Ahmadi et al. 2015; Bärenfänger et al. 2014; Chong et al. 2012; Howells and Wood 1995; Kijsanayotin et al. 2009; Lee and Shim 2007; Matalka et al. 2009; Rickerby 2006; Spanjers et al. 2005; Venkatesh et al. 2011; Wong et al. 2000; Wu et al. 2007, 2011). These studies analyze adoption of ICT systems such as RFID, electronic medical record, electronic patient record (EPR), clinical information system, telemedicine, smartphones, electromagnetic healthcare systems, and other RFID systems in healthcare. They use technology acceptance models and theories presented in technology adoption literature. Although these studies have fruitful contributions on adoption, none of them deal with IoT implementations in healthcare. In addition, most of them do not classify decision variables regarding different types of users perspective.

Although, Ahmadi et al. (2015), Dey et al. (2016), Fosso Wamba et al. (2016), Kuo and Chen (2008), and Lu et al. (2013) classify these variables in different dimensions such as organization, environment, and technology, they are insufficient to focus on the diversity of users' beliefs. In this study, we focus on the adoption of IoT devices in the healthcare domain. We present a detailed analysis of factors that affect the adoption of IoT concept regarding different types of users' perspective. The contributions of this study are (i) to close the gap in literature by addressing IoT adoption in healthcare; (ii) to help decision-makers to understand the main variables which affect adoption decision among different users in terms of top level managers, healthcare professionals, technical staff, and patients; and (iii) to present recommendations for healthcare managers to improve the adoption process of IoT devices in their organizations.

This paper is organized as follows. Section 17.2 illustrates review methodology of our study. Section 17.3 presents the impact of IoT technologies on mHealth. Section 17.4 describes an in-depth review of main factors that affect technology acceptance decision in the healthcare domain. In Sect. 17.5, recommendations for the managers are presented. The conclusion is given in Sect. 17.6.

17.2 Methodology

17.2.1 Review Methodology

We have conducted a literature review on academic databases. We used the following search parameters in ScienceDirect, IEEE Xplore, and Web of Science. We also used Google Scholar to support these databases. In our search query, we used three phrases with logical operators and limit the search with the articles published between 2007 and 2017. Since RFID seems as a prerequisite for the IOT domain (Jia et al. 2012), "RFID" term is also used in the search query. The number of articles which were found in academic databases is presented in Table 17.1. This work was conducted in May 2017; therefore, the number of articles published in 2017 is less than other years. We used the following search query in our search:

$$\left\{\begin{array}{c}\left(\text{" Internet of Things" VIoTVRFID}\right)\wedge \\ \left(\text{healthcareV health V hospital V medical}\right)\wedge \\ \left(\text{acceptance V adoption V" technology adoption "V" technology adoption"}\right)\end{array}\right\}$$

Table 17.1 Number of papers after refining procedure

Database	Database fields	Number of papers before first phase	Number of papers before second phase	Number of papers before third phase
Science Direct	Titles, abstracts, and keywords	29	15	13
IEEE Xplore	Metadata only	64	22	17
Web of Science	Titles, abstracts, and keywords	116	24	10

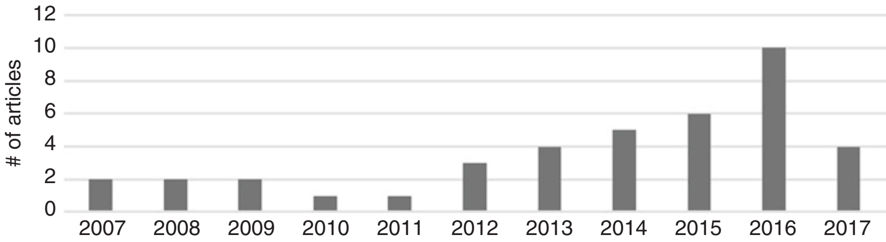

Fig. 17.1 Number of Articles Addressing IoT and RFID adoption in healthcare

We used a refining procedure which is similar to the method presented by Sezgin and Yildirim (2014). After the refining procedure, we selected 40 articles. Addition to these articles, we also surveyed the references of these studies. The steps of this procedure are described as follows:

Phase 1: Abstracts, keywords, and titles of the papers were reviewed. Regarding our topic, most relevant papers published between 2007 and 2017 were considered.

Phase 2: We read all the papers filtered in the previous step. Some of the papers were eliminated due to their irrelevant topic. We considered papers that only focus on IoT and RFID adoption in the healthcare domain.

Phase 3: Methodologies and findings of the papers were reviewed. In Sect. 17.3, we give details about the variables which were addressed in these articles.

The number of papers published in journals and conference proceedings is shown in Fig. 17.1. The figure also presents the increasing trend in IoT and RFID adoption in healthcare domain.

17.2.2 Research Framework

In this study, we used a research framework which is presented in Fig. 17.2. First, we address the importance of IoT adoption regarding the perspective of mHealth. Then, we did a literature search in academic databases by using a group of keywords and focus on the articles which mainly investigate IoT and RFID adoption in the healthcare domain. As a result, we summarize main variables which affect adoption decision among different users in terms of top level managers, healthcare professionals, technical staff, and patients. In addition, we present some recommendations for managers to improve the adoption process of IoT devices in their organizations.

17.2.3 Related Work

After the literature search, we found that the number of studies that investigate IoT adoption in healthcare is very limited when compared with the studies which address RFID adoption. The common points of the studies are they mainly

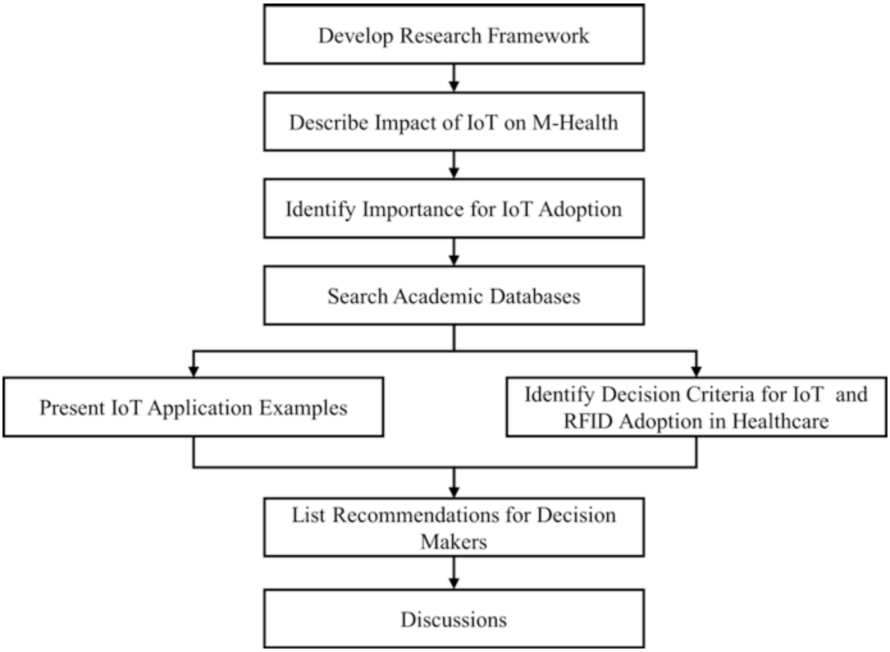

Fig. 17.2 Research methodology

investigate variables that influence adoption of IoT or RFID systems in a healthcare organization and they use surveys to determine these variables. However, these surveys are insufficient to reflect the perceptions of different types of users. In addition, the number of studies that analyze the relation between IoT and mHealth is few. Istepanian et al. (2011), Santos et al. (2014), and Santos et al. (2016) are unique studies that investigate this relation. They propose some theoretical models for integrating IoT capabilities into mHealth applications regarding future Internet. However, technology adoption issues are out of the scope of these studies. It is shown that there is a gap in the literature to analyze the impact of IoT and IoT adoption on mHealth.

In the following sections, we overview the factors that affect IoT adoption and group them regarding stakeholder perspectives. We determine these factors based on previous studies. Since RFID seems as a prerequisite for the IOT domain (Jia et al. 2012), we include the factors that affect both IoT and RFID adoption in healthcare. We mainly use the variables which are discussed in Yazici (2014), Ahmadi et al. (2015), Lai et al. (2014), Fosso Wamba et al. (2013), Yao et al. (2012), and Yao et al.(2010). To support our findings, decision variables described in different application areas by Schmitt et al. (2007) and Wang et al. (2010) are also used in our analysis. In our literature survey, we couldn’t find any study that systematically reviews the literature on IoT adoption in healthcare domain.

17.3 Impact of IOT Technologies on mHealth

IoT was initially proposed to refer to interoperable connected devices with RFID technology (Xu et al. 2014). Today, this technology is identified as the Future Internet with the integration into enterprise IT systems (Thoma et al. 2012) and cloud systems. By using IoT technologies, it is possible to collect, record, and analyze data faster and accurate compared to systems that operate individually (Kulkarni and Sathe 2014). Regarding healthcare perspective, IoT technologies can be used for many reasons. Most known application areas of IoT in healthcare can be listed as: patient monitoring and tracking, inventory management, remote surgery, drug distribution, disease diagnosis, patient well-being, and blood bank management (Atzori et al. 2010; Islam et al. 2015; Kang et al. 2013; Kulkarni and Sathe, 2014; Lin et al. 2014; Yu et al. 2012). As an enabling technology, mHealth plays a key role while implementing some of these applications. It behaves as a remote node that provides connectivity with a central location.

mHealth is referred as the implementation of mobile and wireless communication technologies to facilitate and improve healthcare and medical services (Kartsakli et al. 2014). In this study, we use the term "mHealth devices" for mobile phones and medical hubs, "mHealth application" term is used for the applications running on these devices, and "mHealth solution" is used for all type products that include both hardware and software technology for healthcare. Whatever terms are used in the literature, this technology establishes a connection between patients and healthcare professionals and provides remote healthcare delivery by using network technologies. To achieve success, mHealth solutions should be integrated with smart devices in the local environment. At this point, IoT plays a critical role.

IoT provides an architecture to exchange data between mHealth devices and another type of smart devices located in local environments or body area networks. Virtual links between these devices leverage data quality. Ubiquitous healthcare service delivery and service control in a smart environment can be achieved; for example, the health professional verifies the patient and sends a prescription by using smart devices which are interconnected (Santos et al. 2014).

IoT can be also used as a gateway solution rather than an architecture in mobile health scenarios (Santos et al. 2016). The proposed gateway methodology autonomously collects information about the user/patient location, heart rate, and possible fall detection and forwards this information to a caretaker in the real time. The study shows a ubiquitous communication scenario where heterogeneous devices can communicate without human intervention.

As a result, successfully deployed and widely accepted IoT devices ensures mHealth solutions working properly. By the aid of IoT devices and their IP-based connection architecture, mHealth solutions can process critical data in the real time and transmit these data to remote locations for further analysis or diagnosis. Lack of adoption of IoT devices may cause misuse of these devices, and it will decrease the quality of data which is the main source of mHealth applications. In addition, low adoption level of IoT concept also affects the communication between smart systems and mobile devices. Therefore, to utilize the functionalities of mHealth applications, more effort is required to understand decision criteria of IoT adoption.

17.4 IOT and RFID Adoption in Healthcare

17.4.1 Information Technology Adoption in Healthcare

By the increase in Internet and mobile technologies, healthcare service providers can spread healthcare services to anyone, anywhere, and anytime (Lee and Shim 2007). Although a number of smart solutions are introduced for healthcare operations, many of the healthcare professionals do not have enough training and experience on that system (Venkatesh et al. 2011). As a result of lack of training and experience, the adoption rate of these technologies in healthcare takes longer than other application areas (Chong et al. 2012). And, slow adoption may cause healthcare operation failures (Yao et al. 2010). In addition, the effectiveness and efficiency of the healthcare operations would decrease due to the low acceptance rate of these solutions. Therefore, more research is required to understand main variables that influence information technology adoption in healthcare.

There are several models and theories to investigate the adoption of information technologies. Most known theories can be listed as: diffusion of innovation theory, technology acceptance model (TAM), theory of planned theory, theory of planned behavior (TPB), unified theory of acceptance and use of technology (UTAUT), diffusion/implementation model, technology-organization-environment (TOE) framework, social cognitive theory, and task-technology fit chain. They generally explain user or organization acceptance of technologies. In literature, major of studies – including the studies that we surveyed – use these theories to measure and identify the variables in adoption.

There also exist unique studies which use alternative methods to analyze technology adoption factors. For example, Lu et al. (2013) identify adoption factors by using a combination of multiple decision-making models. The study showed that impact of factors may change depending on several parameters such as application area, organization type, or user expectations. Therefore, investigating adoption in a specific technology area would be beneficial to understand unique factors which are specific to the application area. In some cases, a factor (age, gender, etc.) which has a positive impact on the adoption of a system may not influence adoption on another system in a positive way. Therefore, it is critical to analyze the main factors in IoT and RFID adoption in healthcare domain to provide a better understanding of the adoption of these devices. In the following section, we summarized variables which are addressed in previous studies.

17.4.2 Key Factors in IoT Adoption in Healthcare

Technology adoption studies investigate the variables under similar contexts in terms of technology, organization, environment, human, and innovation. Although the contextual approach provides a better understanding of adoption, it may be insufficient to differentiate the expectations of each type of stakeholder who has different education levels, expertise, or needs. We believe that the impact of the variables on adoption would change depending on the type of stakeholder. In the literature Kim and Kim (2016) compared the factors regarding different user views, however, they only present two type of users in terms of patients and non-patients. In our study, we overview the variables regarding four types of users in terms of top level managers, healthcare professionals, technical staffs, and patients. Some of the factors are listed under more than one category, and the impact of the variables on adoption is presented. This categorization shows "Which factors are more important to adopt IoT solutions?" and "Which variables are more important for whom?" The answer to these questions will provide a better understanding of technological adoption, facilitate adoption process, and develop better devices that fit users' expectations.

17.4.2.1 Top Level Manager Perspective

Cost: The financial capability of the organization is a major constraint in the adoption process (Lai et al. 2014). Chong et al. (2012), Dey et al. (2016), Lai et al. (2014), and Lee and Shim (2007) show that most of the decision-makers consider return on investment rather than initial cost. According to Lee and Shim (2007), managers believe that although RFID technologies cost seems high, it would reduce error rates and improve productivity in customer service.

Technological Factors: The technological capability of the organization and complexity of the new system are considered as a critical factor in IoT and RFID adoption in the literature. Chong et al. (2012), Lee and Shim (2007), and Lian et al. (2014) show that decision-makers pay attention to the technical knowledge of their organization in the adoption process. However, Fosso Wamba et al. (2016) and Lai et al. (2014) show that there is not a strong relationship between the complexity of the system and adoption. Lai et al. (2014) support this idea and present that with the assistance of vendors and partners, organizations are able to overcome the technical problems.

Ease of Use: Zailani et al. (2015) showed that perceived ease of use is not significant for managers to adopt radio-frequency identification (RFID).

Competitive Pressure: In previous studies (Cannon et al. 2008; Chong et al. 2012; Reyes et al. 2012; Vijayaraman and Osyk 2006; Zailani et al. 2015), it is proved that competitive pressure has a positive influence on decision-makers to adopt new technologies. According to these studies, top managers believe that technological improvements will improve organizational capability. However, Fosso Wamba et al. (2016) and Lai et al. (2014) show that competitive environment is not significant factors driving RFID adoption among SMEs. Lee and Shim (2007) revealed that competitive pressure has an indirect effect on the likelihood of adopting RFID. Dey et al. (2016) indicate that uncertainty in the healthcare sector is relatively low compared to other sectors, and compelling rules or policies to use RFID technology in health are not clear which may be the reason of low impact of competitive pressure. As a summary, the relation between competitive pressure and adoption may change depending on the firm size or organization type (Cao et al. 2014).

Organization Size: We found that there are contradictory outcomes in the literature about the impact of the organization on adoption. While Brown and Russell (2007), Iacovou et al. (1995), Lai et al. (2014), and Reyes et al. (2016) show that larger firms are more likely to be associated with a higher adoption stage. Chong and Chan (2012) present that there is not a strong relationship between organization size and adoption. Regarding these results, it is required to consider organization type rather than organization size for predicting and defining the steps of IoT adoption in healthcare.

Managerial Characteristics: Fosso Wamba et al. (2016) prove that education level, gender, and age of managers have a strong influence on the technology adoption process. Although Venkatesh et al. (2014) suggested that younger managers who have higher education are more open to taking the risk for new technologies, Fosso Wamba et al. (2016) found that older managers were more likely to adopt RFID technologies. Van Slyke et al. (2002) investigated the impact of gender for online shopping and found that men are more likely to buy products or services online than women. However, Fosso Wamba et al. (2016) cannot prove the positive impact of male managers on adoption. We believe that more research is required to analyze the impact of age, gender, and education level of managers on adoption in detail.

The Geographic Location of Organization: Fosso Wamba et al. (2016) present that geographic location of the organization has an influence on the adoption of technologies. According to the study, organizations which are located close to metropolitan areas are more likely to adopt RFID technology.

Business Sector: Fosso Wamba et al. (2016) found that type of business sector was not significant on adoption. However, most of the organizations sampled in that study perform in service sector and manufacturing. None of them is healthcare organizations, and therefore the impact of the business sector on adoption cannot be proved.

Country of Business: Fosso Wamba et al. (2016) found that developed countries have positive intention to adopt RFID systems. In our study, we could not find any study that compares the RFID and IoT adoption level between the same types of companies originated in different countries.

Relative Advantage: Perceived relative advantage does not have a direct impact on intention to adopt RFID technologies. Although Zailani et al. (2015) show a weak relation between relative advantage and adoption, Lai et al. (2014) and Lee and Shim (2007) couldn't show the relative advantage as a strong variable on adoption.

Security and Privacy: Zailani et al. (2015) show that security and privacy concerns are significant predictors of hospital managers' intention to adopt RFID technology. If the system has a secure architecture, managers are likely to adopt the system.

Policies and Government Support: Lee and Shim (2007) and Zailani et al. (2015) show that government policy concerns are significant predictors of hospital managers' intention to adopt RFID technology. Kuo and Chen (2008) depict government support as an important trigger for success in RFID deployment projects. Therefore, policies and government support seem as strong motivators in IoT adoption.

17.4.2.2 Healthcare Professionals' Perspective

Perceived Usefulness: Perceived usefulness is an important driver of intention to adopt RFID among healthcare professionals (Zailani et al. 2015). However, more functionality does not mean much usefulness since high automation and elimination of human intervention would bring some risks to users (Cocosila and Archer 2010). Therefore, it is required to balance the level of automation and functionality in the design phase.

Perceived Ease of Use: According to Unnithan et al. (2013) and Zailani et al. (2015), perceived ease of use has a positive impact on RFID adoption among healthcare professionals. The learning curve of the products is also another important issue which affects adoption of the systems (Bellagente et al. 2016).

Education: Abdulaziz et al. (2017) show that main reasons for dissatisfaction were found to be inadequate training and computer skills. They present that technology satisfaction level is higher among nurses who have advanced computer skills.

Security and Privacy: Recent studies show that healthcare professionals allowed the collection of information on the condition that the confidentiality of these data was not infringed. Therefore, security and privacy can be considered as significant factors that influence the intention of technology adoption (Holzinger et al. 2008; Zailani et al. 2015; Khoumbati et al. 2010).

Top Management Support: Top management support has the most significant influence on adoption. Jeyaraj et al. (2006), Dey et al. (2016), Lee and Shim (2007), Reyes et al. (2016), Thong and Yap (1995), and Thong (1999) show the positive influence of top management support in RFID and IoT adoption.

Design: Design parameters can be listed as resistance to environmental conditions, size, transmission jittering, and battery life. The impact of these factors is investigated by Cao et al. (2014). According to the study, well-designed products are adopted easier than other products by the users.

Social Persuasion: Singh et al. (2015) propose that social persuasion has a great impact on technological trends such as IoT and mobile devices.

17.4.2.3 Patients' Perspective

Security and Privacy: Security and privacy are significant factors in adoption (Chong and Chan 2012; Fosso Wamba et al. 2016; Wamba and Ngai 2011). Patients generally do not intend to transmit their personal data over automated systems due to security and privacy considerations. Therefore, security and privacy should be addressed while storing and transmitting individuals' data. Henze et al. (2016) ensure an integrated solution for privacy enforcements for cloud-based IoT concepts. It is proposed that individual end users and developers are regarded at the same time. As a result, it is obvious that there is a need for more work to find out appropriate ways to process personal data in public environment.

Relative Advantage: Relative advantage is one of the important determinants of technology adoption in the user perspective (Rogers 1995). Similarly the RFID and IoT domain, relative advantage is also an important factor (Fosso Wamba et al. 2016), and it has a positive influence on the adoption process.

Word of Mouth: Word-of-mouth and user-generated content are important factors among the end users. Mital et al. (2017) and Roy et al. (2016) propose these variables as a great motivator on the adoption of IoT devices especially among users who have low income.

Gender and Age: Both gender and age are strong predictors in technology adoption (Venkatesh et al. 2014; Yee-Loong Chong et al. 2015). According to these studies, younger users are more likely to adopt technologies than older ones. However, these studies address general technology adoption rather than IoT concept. In our literature survey, we couldn't find any study that investigates the impact of age and gender on the IoT adoption among patients.

Ease of Use and Education: Thaduangta et al. (2016) showed that difficulty of the system and lack of education influence perceived usefulness of the system negatively, and users feel nervous while using the technology. Benoît et al. (2009) found that learning has a positive impact on adoption and provides positive emotions against the technology. Therefore, education seems a strong motivator on adoption.

17.4.2.4 Technical Staff Perspective

Technological Limitations: Technical capabilities and use of common standards are considered as determinants in the technical perspective (Wamba and Ngai 2011; Dey et al. 2016). Lack of technical capabilities and interference with other devices are considered as important barriers to use the RFID and IoT solutions (Lin et al. 2014; Pustiek et al. 2016).

Compatibility Factors: Chong and Chan (2012) found that there is no significant relationship between compatibility and adoption. However, researchers state that compatibility of the system is significant in routinization stage that fully integrates new systems with existing ones after the adoption process. On the other hand, Cao et al. (2014), Dey et al. (2016), Fosso Wamba et al. (2016), and Lai et al. (2014) show that compatibility between new systems and existing devices is important for technical staff. Technicians and IT managers are likely to use new devices if the devices are compatible with the existing systems. In addition, it is proposed that perceived complexity of the systems can be reduced (Chong and Chan, 2012). The flexibility of the technical infrastructure is another determinant if the IT infrastructure of an organization is flexible enough to implement new technologies (Dey et al. 2016).

Table 17.2 Research methodology

Parameter	Variable	Top level managers	Healthcare professionals	Patients	Technical staff
Higher	Cost	N			
	Return on investment	+			
	Technical knowledge	+/N			
	Security and privacy	+	+	+	+/N
	Relative advantage	+/N	+	+	
	Perceived usefulness				
	Ease of use	N	+	+	
	(Lower) Learning curve				
	Competitive pressure	+/N			
	Strict policies and government support	+			
	Organization size	+/N			
	Elimination of human intervention		–		
	Top management support		+		
	Social persuasion		+	+	
	Word of mouth				
	Compatibility				+/N
	Education level		+		
Older	Age	+/–		NMR	
Male	Gender	+			
Closer to metropolitan cities	Geographic location of organization	+			
–	Business sector	NMR			
Developed	Country	+			
Better	Design		+		+
	Technical capability				

+ Positive effect, – negative effect, N no strong relationship, +/N studies are existed show either positive effect or no strong relationship, NMR need more research

Security and Privacy: Privacy and security were rated some of the least concerning aspect by technical staff in RFID adoption (Dey et al. 2016). This is contradictory with previous findings presented in Lai et al. (2014) and Tsu Wei et al. (2009).

Regarding the findings in previous studies, we summarize the variables in Table 17.2. Some of the variables are aggregated under a single term since some studies may refer same concepts by using different terms. "+" shows the variables which have a positive effect on adoption, whereas "–" shows the variables that have a negative effect. "N" depicts the variables which do not have a strong relationship with adoption. "NMR" presents variables which have been addressed but needs more research for detailed analysis. Blank cells show the variables have not been investigated in the studies that we surveyed. These variables and different perspectives are illustrated in Fig. 17.3.

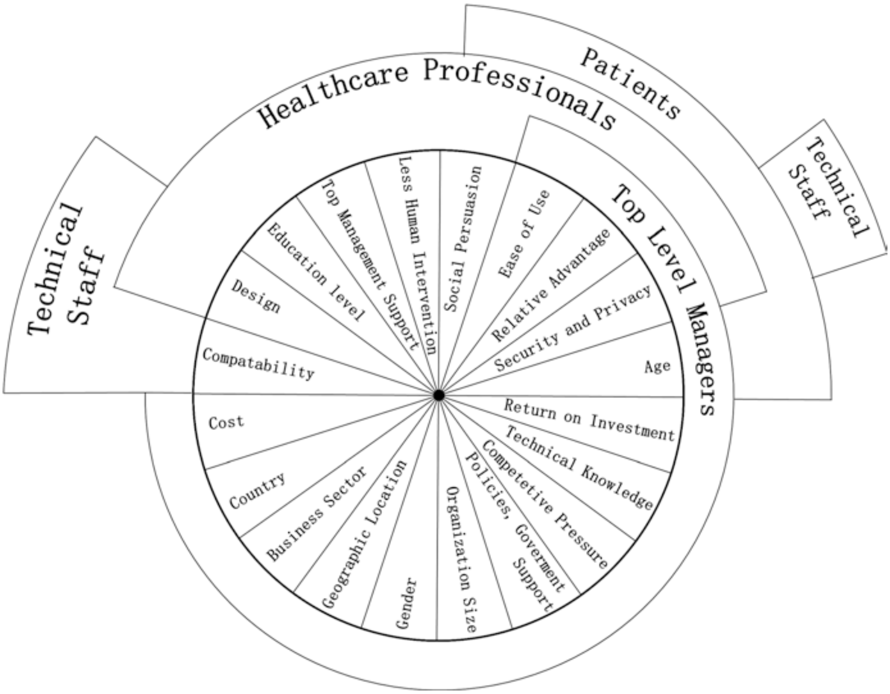

Fig. 17.3 User perspective adoption chart

17.5 Recommendations for Healthcare Organizations and Service Providers

Managers and IT staff of the healthcare organizations need to follow predefined instructions to achieve success in IoT adoption. To address this requirement, we propose the following recommendations to ensure wide adoption of IoT solutions among patients and healthcare professionals. Widely adopted IoT solutions would enable using more mHealth devices in healthcare organizations. In such perspective, these recommendations directly influence the use of m-Heath implementations.

17.5.1 Inform Users

The gap between expectations and actual results has a negative impact on organizational level RFID adoption (Kuo and Chen 2008). If the user perceives that the new system does not satisfy his/her needs, he/she may not adopt and use it. Therefore, organizing events to educate users and using social media platforms and discussion forums would leverage adoption level of the users (Alaiad and Zhou 2017; Unnithan et al. 2013). Informed users will be more motivated to use IoT technologies, which will directly lead to increased use of mHealth solutions in enterprises.

17.5.2 Customize Technology

We believe that there is no a technological solution that fits all cases; in other terms, there is no "silver bullet." "Customization" is a strong motivator in adoption (Unnithan et al. 2013). Therefore, customization of the technology is needed to address actual needs of the organization. Users willingly use the systems when they see that the system has capabilities to accomplish their needs. Such a user motivation will lead to use IoT solutions in corporations. In addition, customization is useful in solving compatibility issues that may arise between IoT solutions and mHealth implementations. Systems that integrate with each other will increase the productivity and efficiency of information systems of organizations.

17.5.3 Listen Users

Previous studies showed that major reasons for IT failures are inadequate understanding of the users' expectations and preferences. Since the only way to succeed in IoT and RFID adoption in healthcare can be listed as considering users' needs, developing user-specific devices, and improving the products based on user feedbacks even after product release. Therefore, developers should pay attention to user needs. Interviews and surveys are the easiest methods to elicit the user requirements. In addition, to identify user needs, previous experiences in mHealth implementations can be also used. User feedbacks on mHealth technologies will contribute to the identification of requirements and development of new IoT solutions.

17.5.4 Ensure Privacy

As shown in the previous sections, security and privacy are the main considerations for all types of users. Developers and organizations should ensure the privacy of individuals' personal information to convince users to use the product. Privacy can be ensured by using two methods (Cicibaş and Demir 2016). In the first method, users set the permissions in their IoT devices by using a privacy language which is similar with a method presented for smartphones (Vincent et al. 2011). In the second method, users are informed about data collection with a message indicating that it is to serve business needs. We believe that the first method is more applicable since users are more familiar with the method which is used in mobile solutions. Current solutions that address mHealth privacy will also meet the privacy issue of IoT solutions.

17.5.5 Use Social Hubs

In organizations, there are popular employees who have an influence on other employees. They can persuade others toward a particular belief (Demir and Ozkan 2015). Managers are also a type of such employees. Organizations should convince these members first and then support them to spread their beliefs to other employees. Therefore, adoption decision can be diffused to other members easily. Similarly, social influence is proved as a strong motivator in mHealth adoption (Sun et al. 2013; Kwon et al. 2016). Although users generally make decisions based on their own evaluations, they are affected by social influence while adopting mHealth technologies (Sun et al. 2013).

17.6 Conclusion

IoT provides an architecture to exchange data between mHealth devices and another type of smart devices which are located in the environment. Virtual links between these devices leverage data quality and improve the efficiency and effectiveness of these devices. Moreover, IoT architecture provides processing data which are collected by different types of mobile devices such as mobile phones, implantable sensors, wearable devices, and ambient-assisted living solutions. Regarding these functionalities, IoT plays a key role in the mHealth domain.

In our study, we investigated adoption variables of IoT in healthcare domain and then summarized these variables regarding perspectives of different types of users. In addition, we listed several actions that could be taken by organizations to leverage the effectiveness of IoT implementations in hospitals or other healthcare organizations.

We found that there is a gap in the literature to explain the adoption of healthcare applications by specifically addressing the unique characteristics of IoT technology. Most of the studies investigate adoption factors in IoT healthcare applications by using the results which are taken in a specific period of time (Kim and Kim 2016). However, it is required to observe long-term perceptions of the users to understand the actual adoption of IoT devices.

As a result, to leverage the effective use of mHealth technologies in multi-technological environments, more research is required. Further studies should analyze the role of IoT in healthcare in detail. We believe that IoT will assist widely deployment of mHealth applications in healthcare. In addition, increasing demand of patients, home-based healthcare needs, and the growth of smart objects will also launch new mobile health applications (Cloudmine Inc. 2016).

Mobile health applications should be shaped regarding the concepts of IoT. During this transformation, we need to talk about mobile-enabled health applications rather than mobile health applications. New services and business models can succeed by using such a consortium.

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