Integrating IoT to Change Non-Functional Requirements for Information Systems Adoption

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Abstract

The integration of the IoT has shifted the focus towards the physical layer of integrated objects and equipment from the perspective of systematic and methodological aspects of business data and applications. The present study aims to introduce quantitative evidence on the impact of integration of IoT with information system on nonfunctional requirements of information systems. The study has employed descriptive correlational design to identify the changes in non-functional requirements by means of IoT integration in information systems. A total of 222 experts and project managers were recruited from 30 firms, who were given a questionnaire to be filled based on 5-point Likert scale. The questionnaire collected demographic detail of the participants and also gathered information related to the changes in functional requirements were provided, which include interoperability and compatibility, scalability and extensibility, reliability, self-adaptation and context awareness, system trust, RFID, sensors, actuators, and embedded software equipment. The results have shown that there was a significant role of interoperability and compatibility, scalability and extensibility, and reliability on Information System Adoption. A significant role of self-adaptation and context awareness, system trust, and RFID is observed on Information System Adoption. A significant role of sensors, actuators, and embedded software equipment is observed on information system adoption. Majority of the functional requirements are likely to change the method of gathering, processing, and communicating data on the basis of business transactions.

Keywords: Internet of Things, Functional Requirements, Adoption, Information System, Electronics, Software

1. Introduction

The whole system in any enterprise consists of two subsystem the physical subsystem and the conceptual system the conceptual subsystem is an information system, which reflects the behavior of any component or element in physical subsystem of enterprise. Therefore, the user Requirements of Information systems fall into two classes functional and non-functional. A functional requirement describes a specific action of task or function of the system when certain event is achieved in physical subsystem, such as booking exit car when it exits from enterprise or attend employee when comes to work.

Internet of Things (IoT) has been referred to diverse network including virtual and physical objects. These objects are embedded with software, electronics, sensors, and connectivity, which facilitate them in achieving greater service and value through data exchange with other objects connected via internet (McEwen & Cassimally, 2013). The term ‘thing’ in IoT may refer to an individual with heart monitor implant or field operation robot with the capability to transfer data that would help in interoperating with the existing internet infrastructure (Stankovic, 2014). An integrated transport system provides an example of IoT-enabled environment that is routed and organized dynamically towards change in the traffic condition and needs (Zanella et al., 2014).

The technology of IoT appeared at the end of 19th century, when the world of electronic business and commerce was fully developed to support the value chain of businesses. Technology is not deemed effective with respect to applicability even though IoT is assumed as a technology that will be developing in the coming years (Zambonelli, 2016). RFID technology cannot be integrated on a large scale due to complexities associated to broad band communications, web platforms and interoperability of systems, and standardization of communication languages specifically of the embedded systems (Chen & Zhao, 2014). Additionally, there was lack of devices, high cost of RFID tags, processing and communication of data, embedded software products, structured or unstructured formats even IoT is used on well-defined business segments (Matos et al., 2015). Platforms based on semantic web and ontology, the Internet of Things, pervasive computing, augmented reality, business intelligence, and large-scale use of data analytics are observed along with the expansion of cloud technologies (Lee, Bagheri & Kao, 2015).

In the reminder sections of this paper are organized as follow, the contributions and limitations of previous works are introduced in section 2. Section 3 introduces the methodology of paper to illustrate how to prepare this study and how to collect the data and analyze it; the results of survey are displayed in section 4, section 5 discuss the results and the conclusion and future works presents in the last section.

2. Literature Review

Previously, several studies have been conducted to investigate security, interoperability, system architecture, and data communication, but studies lack to provide empirical evidence on the integration of the IoT and information systems within the company architecture (Fotache & Cogean, 2013). In contrast, generic enablers, connected and synchronized enterprises, smart enterprises, and sensing enterprises are used with respect to the changes generated by the integration of the IoT within the company's architecture (Păvăloaia, 2013). In addition, an integration and adequate synchronization of systems, companies, and objects are required for overcoming the challenges being experienced by firms using the IoT (Greavu-Șerban, 2015).

The focus has been shifted toward the physical layer of integrated objects and equipment because the integration of the IoT; from the perspective of systematic and methodological aspects of business data and applications, and information systems are not well-researched. However, there are few studies that interactively show the integration of IoT in information systems. For instance, Houyou et al (2012) have shown the integration of IoT in the activation of heating systems and ventilation in food stores on the basis of sensors of actuators to sustain the adequate level temperature of storage conditions. Similarly, Mazhelis and Warma (2013) have shown the efficacy of IoT in automatic data collection regarding activating irrigation and humidity systems, which include the time and periodicity and the quantity of water used. Xu et al. (2014) have integrated IoT devices to record energy and other utilities costs on the basis of actuators and sensors. Similarly, Vicente et al. (2015) have reported the integration of IoT devices for the automatic optimization of transport routes on the basis of traffic conditions using geographical information systems and sensors. On the basis of aforementioned evidences, this study aims to identify the changes in the functional requirements by means of IoT integration in information systems adoption. To the best of the researcher's knowledge, this study will be the first to identify the proposed objective in the context of support provided from changes in functional requirements to IT experts.

According to Muhammad, Amna Pir M. Usman Akram ; Muazzam A. Khan (2016) introduced solutions for data management problems in Hospital management information systems by using IoT and provided that IoT based HMIS would provide better monitoring, communication and early diagnosis (Muhammad, Amna et al., 2016) Some of previous study discussed the framework of information systems based on IoT , such as John Gialelis and Dimitrios Karadimas ,2014 to illustrate how the integration between IoT and Information system are implemented and the achieved benefits that can be met. They introduce resolves for the problems of library services. (Gialelis , John and Karadimas , Dimitrios ,2014). In brief, IoT has some of Benefits and Risks, the figure No 1 summaries them. (Brous, P. , Janssen, M., 2015) (Boulos, M.N.K., & Al-Shorbaji, N.M. , 2014)

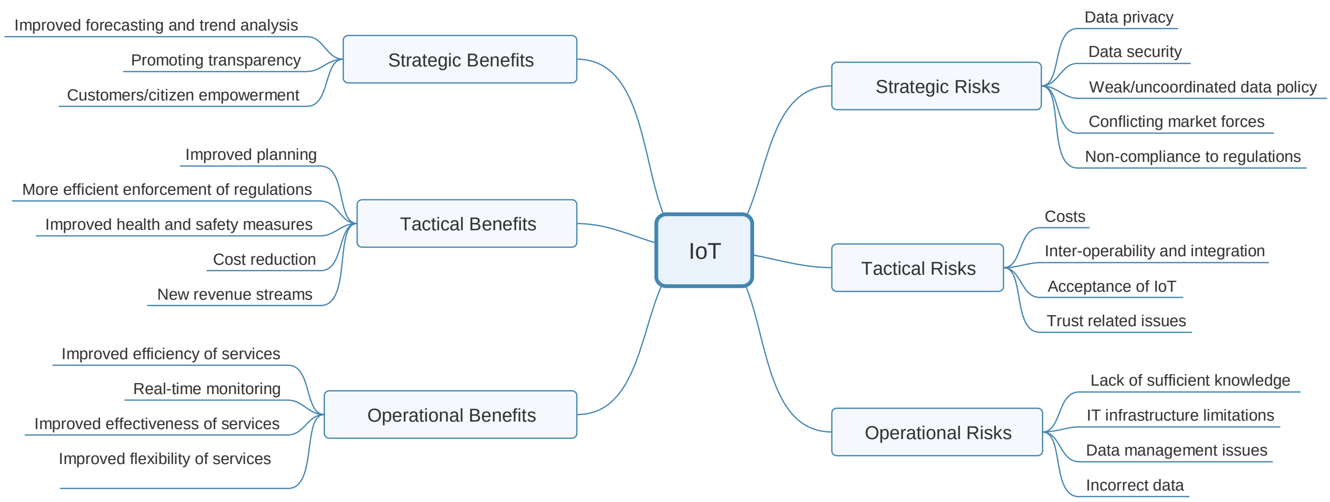

Figure No 1 Summary of IoT Benefits & Risks

3. Methodology

A descriptive correlational design was used to fulfill the proposed objective and to identify the changes in functional requirements by means of IoT integration in information systems adoption. The survey was conducted during the months of April and June 2018 using an online survey to recruit maximum sample. The study has targeted IT firms in the region and IoT experts employed in respective firms. In total, 247 IT experts and project managers were targeted out of which 222 complete questionnaires were received showing 89% response rate. Therefore, the sample size selected for the study was 222 from 30 IT firms.

A rating scale questionnaire has been developed to collect data from selected participants. The questionnaire comprises of two sections; first section provides demographic information of participants, which include their age, qualification, designation, and employment years. In the second section, the information regarding the changes in functional requirements were provided, which include interoperability and compatibility, scalability and extensibility, reliability, self-adaptation and context awareness, system trust, RFID, sensors, actuators, and embedded software equipment.

The data collected was analyzed through statistical software namely statistical package for social sciences (SPSS). A parametric test has been applied due to large sample size and ordinal data. Cronbach Alpha was used to measure the reliability of the survey instrument. In this regard, a pilot test was performed to check the internal consistency of survey instrument and to conform the validity of the survey.

4. Results

Cronbach alpha has been used to measure the reliability and validity of the questionnaire items. The findings have indicated a greater reliability for the questionnaire items, which was sufficient enough to execute the further analysis (Table 1).

Table 1: Questionnaire Reliability

Cronbach's Alpha	N of Items
.959	9

The first section of the questionnaire gathered the demographic details of the participants. The responses of the individuals exhibited that the majority of the participants were male i.e. 183 whereas the number of female participants was 39. Considering the age group of the managers, most of these lie in the 25-40 years age group accounting 44.59%.

The following questions after demographic assessed the profile of the managers and IT experts. Majority of the managers were lower level managers indicated through the increased percentage i.e. 62.61%, followed by middle level managers (22.97%) and IT experts (14.44%). Along with it, the major population of the managers has 5 years of experience (59.0%), reflecting upon their involvement in the organization operations, followed by above 10 years of experience (22.5%) and 6-10 years (18.46%). Considering the education level of the managers, equal population of bachelors and managers was part of the survey i.e. (n = 145), whereas 32 participants hold post-graduate degree (Table 2).

Table 2: Participants Demographics

		N	%
Gender	Male	183	82.43
	Female	39	11.26
Age	Below 25 years	99	44.59
	25-40 years	98	44.14
	40 years or above	25	11.26
Positions	Lower Level Manager	139	62.61
	Middle Level Manager	51	22.97
	IT Expert	32	14.44
Work Experience	5 years	131	59
	6 - 10 years	41	18.46
	Above 10 years	50	22.5
Education Level	Bachelors	145	67.5
	Masters	45	27.5
	Post Graduate	32	10.3
Total		**222**	**100**

The results have shown that there was a significant role of interoperability and compatibility, scalability and extensibility, and reliability on Information System Adoption. The findings have indicated that these changes significantly show a need to adopt information system features in the organization (Table 3).

Table 3: Impact of IoT on interoperability and compatibility, scalability and extensibility, and reliability of Information System Adoption

Information System Adoption			
		N	**%**
Interoperability and compatibility	Yes	181	72.32
	No	41	27.67
Scalability and extensibility	Yes	188	78.6
	No	34	21.4
Reliability	Yes	184	75
	No	38	25

The results have shown that there was a significant role of self-adaptation and context awareness, system trust, and RFID on Information System Adoption. The findings have indicated that these changes are major functional requirements toward any information system deployment within the organizations (Table 4).

Table 4: Impact of Self-Adaptation and Context Awareness, System Trust, and RFID on Information System Adoption

Information System Adoption			
		N	**%**
Self-adaptation and context awareness	Yes	177	68.75
	No	47	33.03
System trust	Yes	189	79.46
	No	33	20.53
RFID	Yes	181	72.32
	No	41	27.67

The results have shown that there was a significant role of sensors, actuators, and embedded software equipment on Information System Adoption. The findings have indicated that these changes significantly show a need to adopt information system features in the organization (Table 5).

Table 5: Impact of sensors, actuators, and embedded software equipment on Information System Adoption

Information System Adoption			
		N	**%**
Sensors	Yes	189	79.46
	No	33	20.53
Actuators	Yes	173	65.1
	No	49	34.82
Embedded software equipment	Yes	183	74.10
	No	39	25.89

5. Discussion

The new revolution in information technology and systems is likely to be indicated through certain concepts; for instance, IoT that is responsible for producing significant changes at the level of information systems. The adaptation of information system to IoT is challenged with various theoretical and practical controversial topics. The present study has approached the infrastructure and architecture perspective that is required for conducting communication. The results have shown that IoT adopted few approaches that relate to data streaming, functional requirements, and data processing. The results have also highlighted the important factors that are important to be integrated into the information system for the newly established synchronized enterprises.

A similar study conducted by Mesnita (2017) showed that the method of gathering, processing, and communicating data is based on the functional requirements that are likely to be generated by the business transactions. This type of processing involves data, which his observed as the main element of technical and engineer systems and are likley to be considered before any business systems (Mesnita, 2017). IoT is likley to induce the functional requirements based on the features possessed by the new system. The transaction processing systems are the most involved systems that are grouped based on the main business processes. Another study conducted by Zambonelli (2016) has shown that the functional systems need to ensure the gathering, processing, and communication of data concerning the sensors that are being embedded in the software devices. The present study has considered the system developments that help in the identification of data representations and communication protocols.

The auto-configuration and self-adaptation of the functional systems is ensured via specific stereotypes that are responsible for sending the require data needed for synchronizing the interconnected components (Da Xu et al., 2014). A study conducted by Fersi (2015) clarified that functionality is an important aspect that is provided to the systems, irrespective of the number of objects that are connected to the specified device. Similarly, the present study has depicted that it is important to ensure the stability and functionality of the information system as it interacts with the surrounding connected devices. Therefore, it has been stated that effective operation on a global scale ensures and provides maximum features to the functional system.

Another study concerned with reliability of information system stated that these systems tend to perform without any sort of interruptoons, except for the interruptions that are scheduled (Ahmad, 2014). However, this feature is difficult to adapt because the system is linked with a number of devices, receives data, signals, and information through various network structures (Da Xu et al., 2014). It has been shown that in the predictable environments the traditional systems are likley to perfrom with planned software updates, stable networks, and relarional databases. These consequences impose significant impact on the non-functional requirements of the information system that requires special attention by the developers. In the similar context, the present study has shown that the systems features are likely to be assessed based on the types of objects connected to them via technical and business operations.

Namirumi (2015) investigated the new features for traditional systems that are important to the systems of pervasive computing. The changes occuring in the information system based on the state of interconnected objects place the developers in a critical situation as it is difficult to fulfil transversal complex requirements. Concerning the system trust, Rudy (2015) showed that interaction of software module develops by different teams that have their own interests and methodologies. It has been shoen that computer systems based in communication standards characteroizes the sensor extension towards the boundaries of IT infrastructure for integration of certain devices.

6. Conclusion and Future Work

The present study has identified the changes in the functional requirements by means of IoT integration in information systems adoption. In the context of IoT, the present study has presented the interaction of information system with external entities. The study results are likely to provide certain identified aspects and requirements that provide support towards the development of information systems that are integrated with IoT. Majority of the functional requirements are likely to change the method of gathering, processing, and communicating data on the basis of business transactions. Recently, the information systems are identified without using any business terms because of the integration of IoT that has resulted in significant changes. Moreover, system requirements are no longer be identified by talking to system users because individuals have a new meaning reflected by objects and devices connected to the world of business. However, the study results are limited because it lacks validation and it has only recruited experts and project managers from 30 firms. Future studies need to consider large number of firms to obtain generalized results regarding the integration of IoT in ordeer to change the functional requirements to adapt to the information system. Another perspective of future work is studying the impact of the integration of the IoT and blockchain on the functional requirements of Enterprise information systems.

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