An Investigation on the Factors that Influence Readiness of Internet of Things Adoption in Education Sector

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ABSTRACT

Towards year 2050, Malaysia National Mission is to strengthen the economy in moving towards Industrial 4.0 Revolution. This involves high skills and advanced technology of Information Technology (IT). One such application that is rapidly changing the people life style with regards to this is the Internet of Things (IoT). Therefore, user readiness in adopting the new technology like IoT can support these missions which require certain level of readiness among the people. IoT adoption is difficult to be implemented if there is users are not ready. It also can affect the development of technology and country. The purpose of this study is to identify the factors that influence the users' readiness of IoT adoption in the education sector, rank the users' readiness and identify relationship between the factors towards user readiness using Pearson's Correlation. From the review of the literature, several factors such as ICT infrastructure, ICT knowledge, ICT skills, societal, cost, trust, and politic were among the identified factors that influence users' readiness. The focus area of IoT was centered on education sector particularly on smart devices and its applications in order to realize the outcome of smart university. A survey was conducted involving 335 students in one of Higher Learning Institution in Northern Malaysia. The results indicate that users' rating readiness in terms of high level application where the factor has significant relationship towards the user's readiness.

Keywords: Internet of Things, education, smart devices, smart university.

I INTRODUCTION

Malaysia as a developing country is striving towards achieving the national mission - Vision 2020 in the three years. Now Malaysia needs to prepare itself for the next 30 years. Therefore, National Transformation 2050 (TN50) was introduced for vision beyond 2020 which is from 2021 until 2050. Malaysia TN50 mission is to become a top 20 nations in economic development, social advancement and innovation, thus technology is one of the key points to achieve the mission. In the year 2015, Ministry of Science Technology and Innovation (MOSTI) and Malaysian Institute of Microelectronics Systems (MIMOS) has introduced National Internet of Things (IoT) Strategic Roadmap as a preparation for Malaysia to face technology development especially IoT. Recently, Industry 4.0 Revolution has seen as an emerging agenda due to the IoT development. There are around 42.5 billion career opportunities in Malaysia in the 2025 (MIMOS, 2015). Hence, we need high skills workers to manage these advanced technologies.

Besides that, through the revolution, a little change has occurred in organizational development and knowledge management. This study is a process for managing knowledge and technology as for Malaysia can produce generations that capable of contributing to economic development especially in education sector. In addition, IoT technology that can be utilized in the education sector can helps the users to make a better future in producing generations with great technology management skills.

Malaysia is fortunate to be surrounded by encouraging environment and has strong starting point to foster and spur IoT within the domestic market. This is due to high mobile penetration among Malaysians which approximately 143.7 percent and Internet users being 65.8 percent of which 59 percent is considered as active users (MIMOS, 2015). This situation leads to many challenges to unleash the full potential of IoT. One of the main issues is the readiness of Malaysian users in facing changes of new technologies like IoT adoption. Foundation to the IoT technologies is sensors and actuators (Bagheri & Movahed, 2016) connectivity (MIMOS, 2015) and people including processes. IoT basically is about interaction between things, people and environments supported by technologies. IoT has leveraged many industries such as healthcare systems, traffic management, energy management, education, environment monitoring, smart homes, and smart cities.

Parallel to the issue raised, education is one of important sectors that will be affected by the situation. Education is an important sector because this sector will produce generation of IoT (gen-IoT). Education pedagogy also affected when most of teaching and learning tools will be using the IoT

application technology (Zhu, Yu, & Riezebos, 2016). From the issues raised, it is evident that Malaysia requires more information particularly with regards to IoT readiness in preparing itself to face the challenges upwards. Thus, this research intends to investigate the factors that influence the user readiness in IoT adoption and then further classify the level of user readiness accordingly.

This article is organized as follows; the next section will elaborate further on related work to IoT and education followed by presenting the conceptual framework of this study. Next the methodology of the study is discussed, followed by presenting the results and findings. The article then discusses the results further by providing critical analysis of the data gathered from the study before it finally concludes and shared some potential work related to the study.

II RELATED WORK

In this section will discuss more on the important term related to the study. The Internet of Things (IoT) will link billions of devices to the Internet and redefine how individual people, economic entities, and government organizations will interact with the physical world. IoT is a development of new era technologies which have many connected devices offer interesting and innovative services in the various domain of application (Sicari, Rizzardi, Grieco, & Coen-porisini, 2015).

A. IoT in Education

Education has changed from the traditional teaching and learning in which; the knowledge transfer model to an active collaborative self-directed model by disruptive influence of the technology in the educational institutions (Bagheri & Movahed, 2016). The teaching and learning techniques for the future will be different to the previous years. Smart education is an example of IoT environments which is having several interconnected devices such as hand phone, tablets, education applications and others (Zhu et al., 2016). Smart education also can be understood by new educational model which is based on the connected smart devices and also known with several terms such as smart learning, smart school, smart class, and everything related to smart things. Every user should know the fundamental of IoT in education to realize the smart education and proceed to adopt it. The term smart in IoT can be interpreted in many ways by different entities and educational circumstances. In this project, users should understand in three ways as a learner, technology and educational environments perspectives which users can improve their ability to solve problems efficiently and also effectively using scalable technology resources. Figure 1 illustrates IoT landscape with regards to education sector which is considered as IoT environment.

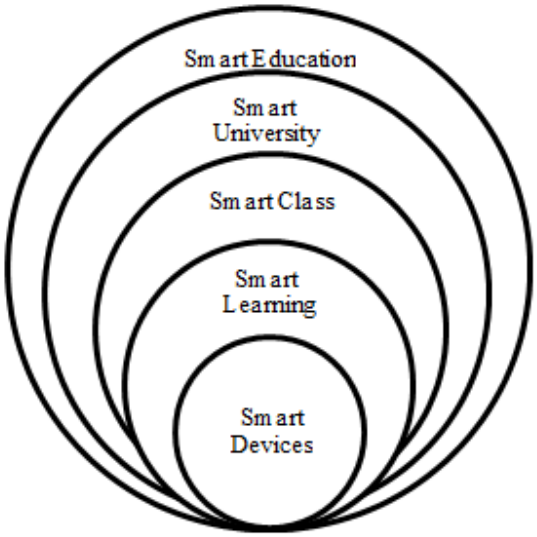

Figure 1. IoT Landscape in Education.

B. User Readiness

Many IoT applications will support the educational pedagogy in the universities such as secure campus and classroom access control, student's health monitoring, improving teaching and learning like e-books, tablet, fitness bands, sensors and others (Bagheri & Movahed, 2016). There have been case studies conducted to show how IoT can improve the efficiency of teaching and learning. For an example wearable technology like *Google Glasses* and *Sony Smartwatch* are used in the Universitat Politecnica de Valencia classrooms to allow lecturers to collect essential information regarding students in as part of the process of building knowledge database (Bagheri & Movahed, 2016).

One of the main reasons why user readiness is an important study to be conducted is due to education which plays an important roles to achieve the IoT adoption goals. Furthermore, existing studies on readiness are more interested in focusing on technology, organization and government aspects (Chang & Kannan, 2006; Dzhusupova, Shareef, Ojo, & Janowski, 2010; Lee & Huang, 2002; Mahat, Ayub, Luan, & Wong, 2012). Nevertheless, individual users are as equally important as those sectors since they play an important role in determining the success of IoT implementation.

Among those researches that are considered related to readiness are for example, Atayero, Oluwatobi, & Alege (2016) who discussed about assessment of IoT adoption readiness of Sub-Saharan Africa (SSA)

economic. They examined the top ten countries in SSA and other regions and come out with several factors that affect the level of readiness of each country which then proposed indices to assess those factors. Another group of researchers, Tubaishat & Lansari (2011) conducted a study on readiness of students in adopting of the e-learning who later suggested several factors affecting students' readiness.

C. Factors of User Readiness

There are many possible factors that may affect readiness of users and adoption of technology in any country especially for developing country like Malaysia. From previous research that focus on economic readiness, these elements like ICT skills, ICT infrastructure, ICT education, favorable institutions, sophisticated markets, competitiveness and enabling environment influence them (Atayero, Oluwatobi, & Alege, 2016).

While in the case of readiness of e-learning adoption among students that stated by Tubaishat & Lansari (2011), they evaluate five factors which are infrastructure, internet use, students' computer skills, confidence development, preferred mode of communication and students' perception of e-learning. Another researcher also state six factors that influence their readiness in area of adopting Web- enhanced Instructional Technology which are knowledge and skills, resources and support and lastly press and spirit (Lee & Huang, 2002). It has shown that there are many factors affecting user readiness in adopting technologies similar to the adoption of IoT. Web-enhanced instructional technology and e-learning are examples of the IoT in the education area.

Thus, this study intends to investigate further, what are among possible factors that may affect users' readiness on IoT adoption in education especially in smart universities (Zhu et al, 2016) applying the usage of mobile devices and and other smart applications in university. The following section will discuss further those factors involved in this study.

III THE CONCEPTUAL MODEL

This study centers its focus on seven factors identified that seems to be possible in influencing users' readiness towards adopting IoT in education sectors. Based from the literature analysis, those factors are 1) ICT infrastructure, 2) ICT knowledge, and 3) ICT skills.

These factors were identified based on analysis of previous studies mainly from Al-momani, Mahmoud, & Sharifuddin (2016) which review Technology Acceptance Model (TAM), Unified Theory Acceptance and Use of Technology (UTAUT) and other nine literature review to propose conceptual model. From the table of frequency that make by Al-momani, Mahmoud, & Sharifuddin (2016), this study compare with another paper like MIMOS (2015) and Atayero et al. (2016). In the MIMOS paper state that four factors for readiness of Malaysia and Atayero et al. (2016) make some preliminary assessment of Sub-Saharan Africa adoption readiness using several existing index such as Network Readiness Index, ICT Development Index and others. Based on the selected factors, a conceptual model is constructed. The development of the conceptual model intends to demonstrate relationships that exist between factors and users' readiness. The factors are selected because these are the most fundamental success factors for IoT adoption like stated in (Halper, 2016) which are study in different dimension in IoT adoption.

ICT infrastructure: Infrastructure is the most important factor in adopting technology and evaluating the users' readiness. Most researchers (Asir, 2016; Atayero et al., 2016; Tubaishat & Lansari, 2011; Zhu et al., 2016) refer infrastructure as part factor that discussing in their paper. Infrastructures are anything that need to connect to the devices such as network connections services (Atayero et al., 2016; MIMOS, 2015), electricity (Asir, 2016), smart devices such as computer, laptop, smart phone (Tubaishat & Lansari, 2011) or any infrastructures that need to improve reach of users to the resources. Performance and innovations of the infrastructures also can influence the user readiness. IoT is new paradigm that need latest version of technology infrastructures.

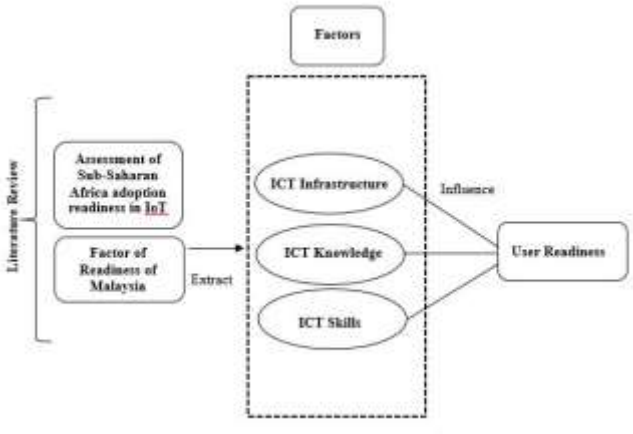

Figure 2. The Conceptual Model

ICT knowledge: Knowledge about ICT is the crucial things to make the technology useful to users. Implementation of technologies among the various background of users need some considerations about

knowledge and preparations to them. In other papers, researchers also mention about education (Zeng, 2011) of using technology like internet, hardware devices and software applications which are the component of IoT. Knowledge in handling teaching and learning can impact the activities of education.

ICT skills: New evolution of technology such as IoT is related too many devices. Almost all of the technology needs skills. Most of component in university and class equipped with the presentation software, laptop or computer with latest operating system videoconferencing, multimedia (Lee & Huang, 2002) needs high users skill to handle problem in teaching and learning processes. Lee and Huang (2002) also said that training should be provided to overcome the constraint.

IV METHODOLOGY

The aim of this study is to identify the factors that influence user readiness in the IoT adoption. The factors identified was based from the literature review. The methodology is divided into three main phases as below:

A. Phase 1: Define Problems, Objectives, Scope And Literature Review

The problems and issues found from the previous study and the output of this phase is problem statements. Objectives, questions, scope and significance of study will be created. This phase also classified the factors of user readiness from several factors that can influence the readiness based on the most common factors. From the review, three factors are identified which are ICT infrastructure, ICT knowledge, and ICT skills.

B. Phase 2: Survey Design

Sampling Design: This study was carried out in one of the Higher learning Institution in Northern Malaysia involving 400 respondents. Simple random sampling is used to collect data in this study. This study used questionnaires to collect data. According to Sekaran (2000), the questionnaire is the best data collection method when the researcher needs a lot of respondents. Four (400) hundred student were selected as a sample group from the total of twenty nine (29 000) thousand student from a university at Northern of Malaysia.

Instrument Design: The questionnaires consisted of two parts. Part 1 consists of 10 questions based on the demographic of respondents and part 2 was divided into three parts which consist of 4-5 questions that concern the factor affecting the users readiness. All questions was designed as short and simple as possible so that the respondents can easily understand. Most of the questions is adapted from the previous research findings (Kim, 2008; Tubaishat & Lansari, 2011; Mahat et al., 2012).

Hypotheses:

H_1) There is a significant positive effect of ICT infrastructure on the users' readiness in adopting IoT.

H_2) There is a significant positive effect of ICT knowledge on the users' readiness in adopting IoT.

H_3) There is a significant positive effect of ICT skills on the users' readiness in adopting IoT.

C. Phase 3: Data Collection And Analysis

Data Collection: The questionnaires distribution was conducted on random basis which resulted in selected 400 responses obtained. The questionaires was developed using Google form and was administered to field test the items. Secondly, by considering some challenges of getting responses, traditional method of distributing questionnaires was also conducted. The aim of doing both modes is to increase the response rates. A total of 379 responses were obtained but only 335 were fit to be analyzed.

Measurements: All the factor levels was classified based on the mean score. Those mean score are then referred to the respective categories to indicate whether the factor level falls under low, medium or high category (Refer Table 1). Based on those classifications, it is then proceeded to the next stage which is to determine the level of user readiness. All data was analyzed using SPSS version 22.0.

Table 1. Classification of Factors Levels.

Mean Score	Classification used for Factor Levels
1.00-2.33	Low
2.34-3.67	Moderate
3.68-5.00	High

V ANALYSIS AND FINDINGS

This section discusses the results of the analysis covering the demographic of the sample, followed by an analysis of the overall mean for seven of the factors that influenced the level of user readiness in the IoT adoption. Descriptive statistics such as the frequencies and percentages were used to describe the sample study profile.

A. **Demographic Details**

The demographic details of this study includes sample profile such as the respondents background and their educational background. The majority of respondents were female students compared to male students, 82.1 percent female students and 17.9 percent male students. Most of the respondents involved in this study aged 18 to 24 with a percentage value of 85.7 percent compared to those aged 25 to 34 who only had 10.1 percent followed by 2.7 percent aged 35-44, 0.9 percent 45 and above and 0.6 percent less than 18. Based on the educational level, most of respondents are among degree students which are 76.4 percent and followed by foundation (10.7 percent), master students (8.1 percent) and PhD (4.8 percent).

B. **Overall Mean**

Level of factor is determine by overall mean for the seven factor as in Table 2 is used to determine the factors that influence the readiness of users in IoT adoption. The highest mean obtained is for political (Mean = 4.0657, Std.Deviation = .62680), followed by societal (Mean = 3.8890, Std. Deviation = .56023), ICT infrastructure (Mean = 3.8776, Std. Deviation =.44824), security and trust (Mean = 3.8097, Std. Deviation =.53732), ICT knowledge (Mean = 3.7648, Std. Deviation = .54812), ICT skills (Mean = 3.7606, Std. Deviation = .49197) and in the Table 3, level of readiness is high when mean = 3.7731 and std. deviation = .48211.

Table 2. Level of Factor.

Items	N	Mean	Std. Deviation	Level of Factor
ICT Infrastructure	335	3.8776	.44824	High
ICT Knowledge	335	3.7648	.54812	High
ICT Skills	335	3.7606	.49197	High

Table 3. Level of Readiness.

Items	N	Mean	Std. Deviation	Level of Factor
User Readiness	335	3.7731	.48211	High

C. **Correlation**

The rate of correlation is in Table 4. The overall construct has a positive and significant relationship ($p = 0.00 < 0.05$). The strength of the relationship between constructs is between weak and strong (Fauzi, Jamal & M. Saifoul, 2014).

Overall the construct has a significant relationship between each other with $p < 0.05$ but in the different level relationship according to table of correlation coefficient in the Fauzi et al (2014). The first construct, ICT infrastructure has a significant relationship with a weak level towards user readiness ($r = 0.181$), ICT knowledge has significant relationship with moderate level towards user readiness ($r = 0.446$), and ICT skills has significant relationship with strong level towards user readiness ($r = 0.642$).

Table 4. Pearson Correlation.

Item	User Readiness	
	Pearson Correlation	Sig. (2-tailed)
ICT Infrastructure	0.181**	0.001
ICT Knowledge	0.446**	0.000
ICT Skills	0.642**	0.000

VI DISCUSSION

The discussion for these findings is based on the three factors that influence the readiness of users in the IoT adoption. The overall levels of user readiness among the university students are at high levels. This study seems to be consistent with Tubaishat & Lansari (2011) which has a high level of readiness towards the adoption of e-learning in the institution.

From this study it was found that user readiness is a new field and did not receive enough attention from many parties, especially students at the tertiary level. However, Malaysia's efforts to improve user readiness are obtained, as this study shows that the level of user readiness is at high level while some factors need to be addressed.

Based on the findings discussed in the previous sections, there exist relationships among all the seven factors. ICT skills towards user readiness among students at a university in Northern Malaysia are at strong level. The previous researcher also state that student technical skills has improve towards using e-learning that is one of the IoT application (Tubaishat & Lansari, 2011). The result contributes positively to the students. Furthermore, most of the students have laptop and hand phone to survive at the university.

ICT knowledge towards the readiness of users are at a moderate level. Most of university students have ICT knowledge and frequently using many devices and interact with many platform of IoT, so it influence the readiness of users in term of knowledge.

Another factor which are ICT infrastructure is in the weak level. This findings is slightly different from Thubaishat & Lansari (2011) because students are mostly satisfied with the infrastructure. Respondents' study in the previous research is among students who are taking the Introduction to IT and systems course at the college of IT in the area of e-learning.

VII CONCLUSION

Overall this study identify the three factors utilize that influence the user readiness in IoT adoption which are ICT infrastructure, ICT knowledge, and ICT skills.. These factors are chosen because it is the most crucial factors in the studies and give big effect to readiness in technology, economy and others.

The study finds that user readiness among students of the university in Northern Malaysia is at high level. In addition, ICT infrastructure, ICT knowledge and ICT skills levels towards user readiness among the university students are also at high levels of readiness.

Pearson correlation analysis also shows that there is a significant relationship between ICT infrastructure, ICT knowledge, and ICT skills towards user readiness. There are weak, moderate and strong relationships of the three factors towards user readiness. The weak relationship in this study is ICT infrastructure. The factors that have moderate relationship is ICT knowledge and the strong level is ICT skills.

The implication of this study is to encourage and improve user readiness among students to improve the quality of teaching and learning in line with the development of current technology. The university also needs to take initiatives through IT and ICT education to increase readiness to implement IoT. In addition, the seven factors mentioned in this study on user readiness need to be taken into account in increasing student readiness among students.

Since this study involved only small group of sample among university students who have high educational background, therefore it would be interesting to involve more sample of the respondents in the macro level instead of micro level only. This study can be conducted among Malaysian population which has different geographical area because rural area and urban area can affect the level of users' readiness. Another potential future work to be carried out is to look at other factors that may be relevant to user readiness which is not covered in this study. Currently this study focused on quantitative approach whereby it can be extend to the qualitative study to get more feedback from interviewing experts or individual users directly to obtain clearer picture of the issues.

ACKNOWLEDGEMENT

This research was supported by Fundamental Research Grant Scheme (FRGS – S/O Code: 13143) from the Ministry of Education (MoE) Malaysia.

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