Users' Intention in Developing Internet of Things in Education Context using the Technology Acceptance Model: A Case Study

(Niat Pengguna dalam Membangunkan Kebendaan Internet dalam Konteks Pendidikan menggunakan Model Penerimaan Teknologi: Satu Kajian Kes)

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Abstract

Internet of Things (IoT) is becoming prevalent in today's technologies spurs by the growth in connectivity as well as innovation in smart devices. IoT is a device that is interconnected and connected to the internet, capable of operating without any human interference or feedback, and capable of making decisions on the basis of data collected through sensors. In this study, the relationship of Perceived Ease of Use, Perceived Usefulness, Perceived Enjoyment, Attitude Towards using IoT technology and user's Behaviour Intention to Develop was investigated and analyzed using multiple linear regression. A short course on IoT development was conducted and participated by students and lecturers in three different sessions. The course requires some knowledge in programming (for android app development) and electronic component (for IoT device) which proved quite challenging as the participants have different levels of experience for both programming skill and electronic knowledge. The result shows that although only PU was found to be significant in the relationship with BI, the other factors (PEOU, AT, and ENJ) taken in as a whole with PU do account to 52.7% variation in predicting user's intention in developing IoT project. The study also found that PU stood as the most important predictor to the user's intention to develop IoT followed by AT, ENJ, and lastly PEOU. IoT development was deemed as requiring more effort by respondents indicates by the least significant factor which is PEOU. This may be caused by the respondents' lack of knowledge in certain skills needed in the endeavor. The results presented here may encourage the development of IoT technologies from members of educational institutions as it is expected to become a highly-skilled workforce. Future research directions are also presented to be undertaken by the interested parties.

Keywords: IoT, Technology Acceptance Model, Education, PEOU, PU.

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INTRODUCTION

Internet of Things (IoT) was said to be one of the emerging technologies that will drive the Industrial Revolution also known as IR4.0 (Maddox, 2019). Unintentionally coined by Ashton in 1999, he emphasized that 'things' is the main component of the world (Ashton, 2009). As such, 'things' played a more important role in technology as oppose to ideas and information which were more prominently used in today's technology. Ideally, IoT is devices that were interconnected and connected to the internet capable of operating without any human intervention or input and able to make decision based on the data gathered via sensors. With rapid improvement of communication and network technologies, development of systems and devices for IoT was gaining momentum. In the past two decades, IoT acceptance and usage has been studied extensively.

There were numerous studies that utilised Technology Acceptance Model (TAM) as instrument to discover factors influencing IoT adoption in various setting such as education (Salah Hashim & Amin Al-Sulami, 2020; Tantiponganant & Laksitamas, 2014; Zarafshani et al., 2020), healthcare (Dhanvijay & Patil, 2019; Yuan & Cheah, 2020), consumer (AlHogail, 2018; Mącik, 2017) and business (Patil, 2017). However, to the best of authors' knowledge, no study has been found so far in regards of user's intention to develop IoT project. Thus, this paper aims to discover the influence of Perceived Usefulness (PU), Perceived Ease of Use (PU), Attitude Towards using IoT (AT) and Perceived Enjoyment (ENJ) on user's behavioural intention in developing IoT project (BI) in education context.

LITERATURE REVIEW

TECHNOLOGY ACCEPTANCE MODEL

According to AlHogail (2018), TAM is a general principle in information system that model the way user embraces and uses technology. While TAM suggests that there are several variables that affect users' decisions as to how and when they can use the recently introduced technology (AlHogail, 2018), the most frequently factors included in user's acceptance investigation were the perceived usefulness and perceived ease of use originally proposed by Davis (1989), and attitude towards technology (Fishbein & Ajzen, 1975). Davis defines perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance", perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort", whereas behaviour intention is defined as "the degree to which a person has formulated conscious plans to perform or not perform some specified future behaviour".

IoT IN EDUCATION

The growth of IoT technology depends on the people who will develop the application, system, or components needed in ensuring the technology works as needed. As such, it is imperative for educational institutions to provide the necessary platform for IoT learning with aims of producing IoT-skilled workforce capable of not only implementing IoT application but also designing and developing it (Al-Emran et al., 2020; He et al., 2016). Integrating IoT into new curriculum gives students a greater chance to perform further for this expanded skillset and industry (He et al., 2016). Still, there were arduous challenges need to be faced in this undertaking such as reducing time latency in the enterprise architecture used for hosting IoT applications (Aldowah et al., 2017), developing relevant IoT curriculums for students and training program for instructors, the cost and life span of IoT devices (Letting & Mwikya, 2020), connectivity issues (Al-Emran et al., 2020) and security and privacy issues (Al-Emran et al., 2020; Aldowah et al., 2017).

RESEARCH MODEL AND HYPOTHESES

This study explores the relationship between the factors that may perhaps affect the users' acceptance of IoT technology especially in the context of education, by desiring to continue developing other IoT projects after getting the exposure from a short IoT development course. A research model illustrated in Fig. 1 was proposed to achieve this purpose. As such, the following hypotheses were proposed:

H1: Perceived Ease of Use (PEOU) has a significant influence on user's Behaviour Intention to Develop IoT project (BI)

H2: Perceived Usefulness (PU) has a significant influence on user's Behaviour Intention to Develop IoT project (BI)

H3: Perceived Enjoyment (ENJ) has a significant influence on user's Behaviour Intention to Develop IoT project (BI)

H4: User's Attitude Towards using IoT (AT) has a significant influence on user's Behaviour Intention to Develop IoT project (BI)

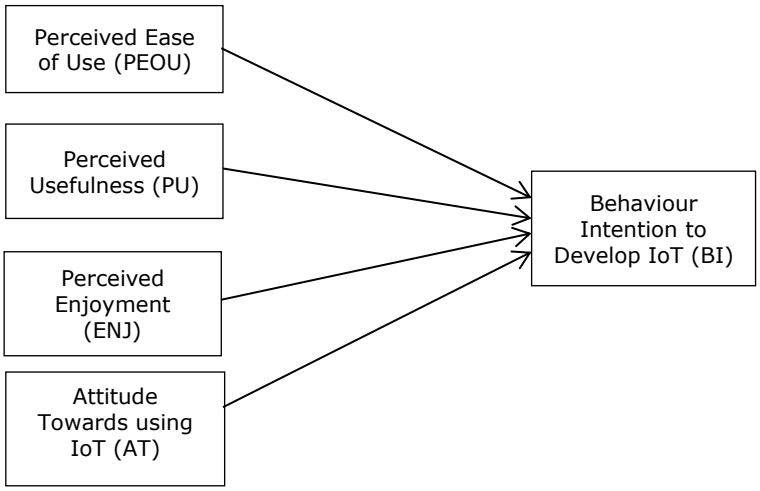

Figure 1. Proposed Research Model

METHODOLOGY

RESEARCH PROCEDURE

The respondents of this study comprised of participants of an IoT development short course conducted over a period of two days. The course was done in three different sessions for three different groups of participants. A survey questionnaire was then distributed to 75 participants at the end of each session but only 53 responses were valid and entered as the data for this study. During the course, participants were guided into developing a simple IoT project using NodeMCU ESP8266 board that can be controlled via Google Firebase and a simple Android app. The NodeMCU ESP8266 was programmed using Arduino IDE 1.8.8, while the Android app was developed using Android Studio 3.1.2.

PARTICIPANTS

The respondents of this study consisted of participants of the short IoT application development course. The first session of this course was attended by 30 Bachelor students of Physics Faculty from UiTM Jengka, Pahang, while the second session was by 30 final semester students of the Diploma in Digital Technology, and the last session was attended by 15 lecturers of the Information Technology and Communication Department, Politeknik Muadzam Shah.

SURVEY INSTRUMENT

There were two parts in the survey instrument used in this study. The first part covered the demographic data of the respondents varying from age group, gender, education background and their experience in programming and electronics as well as their awareness of IoT technology. The second part consisted of the five constructs measured using a five-point Likert scale specifying users' agreement to the statements in the constructs ranging from Strongly Disagree (1) to Strongly Agree (5). The constructs used in measuring users' behaviour intention towards developing IoT project were Perceived Ease of Use (PEOU), Perceived Usefulness (PU) Perceive Enjoyment (ENJ), Attitude Towards using IoT (AT), and Behaviour Intention to Developing IoT project (BI).

ANALYSIS SOFTWARE

The analysis of this study was done using IBM's SPSS 20 (Statistical Package for the Social Science). As this study was mainly exploring the relationship between different factors denote as dependent and independent variables (DV and IV), this software's major usage for hypothesis testing was appropriate as a tool in analysing the data collected (SPSS Statistics - IBM Data Science Community, n.d.).

FINDINGS AND DISCUSSION

DEMOGRAPHIC

The demographic data in Table 1 reveals that 67.9% of the respondents were female and remaining 32.1% were males. As most respondents were students, the age group between 20 – 25 years old make up for 75.5% of the respondent, while 3.8% were both from 26 -30 years old and 31 – 35 years old group. The last age group consisted of those over 36 years old with 17% of the total respondents. Meanwhile, 37.7% of the respondents were from Diploma level background, 45.3% were from Bachelor background and 13.2% and 3.8% were from Master and PhD level respectively. This table also shows that 73.6% of the respondents had less or no experience in programming and only 26.4% respondents had more experience in programming. The percentage for experience in electronic were more balanced with 47.1% had less or no experience and remaining 52.9% had more experience in electronic. The last demographic data collected was the respondents' awareness of IoT with 13.2% of the respondents were completely not familiar with IoT technology, 20.8% had heard about IoT, and 62.3% had some prior knowledge of IoT.

DESCRIPTIVE STATISTIC AND RELIABILITY ANALYSIS

The mean values of all items used in the survey questionnaire were in the range of 3.6226 to 4.4528 which showed that largely the respondents were in agreement or neutral to the items. Meanwhile, the value 0.7 to 0.95 was deemed as acceptable alpha values (Nunnally & Bernstein, 1994). However, another researcher stated that for four or five items the approximate alpha value of 0.65 are satisfactory, while for ten to fifteen items, 0.75 to 0.80 are appropriate (Trevethan, 2009). Most studies discussed the acceptable alpha value on the low end which was above 0.70 (Ramayah & Ignatius, 2005; Zarafshani et al., 2020), very few studies were found discussing on the higher end of the acceptable alpha value. Dennick and Tavakol (2011) summarized that alpha value was influenced by the number of items analysed and its dimensionality, therefore a higher value than 0.90 may indicate redundancies of items especially with a large number of items and recommended a reduced number of items. Based on Table 2, all constructs in this study were judged as reliable.

Table 1. Demographic profile of respondents

Demo. Characteristic	**Freq.**	**%**	**Demo. Characteristic**	**Freq.**	**%**
Gender			**Programming Experience**		
Male	17	32.1	Inexperienced	16	30.2
Female	36	67.9	Less experienced	23	43.4
Age			Moderately experienced	13	24.5
20 - 25	40	75.5	Highly experienced	1	1.9
26 - 30	2	3.8	**Electronic Experience**		
31 - 35	2	3.8	Inexperienced	5	9.4
≥ 36	9	17	Less experienced	20	37.7
Education Level			Moderately experienced	26	49.1
Diploma	20	37.7	Highly experienced	2	3.8
Bachelor	24	45.3	**IoT Awareness**		
Master	7	13.2	I am not familiar with IoT Technology	7	13.2
PhD	2	3.8	I only heard about IoT Technology	11	20.8
			I have some knowledge about IoT Technology	33	62.3
			I know all about IoT Technology	2	3.8

Table 2. Reliability of measurement instrument

Constructs	**Num. Of Items**	**Mean**	**Std. Deviation**	**Cronbach's Alpha**
PEOU	4	3.6226	0.68575	0.790
PU	3	4.3962	0.59935	0.859
PE	3	4.2642	0.81219	0.891
AT	4	4.4528	0.57399	0.790
BI	3	4.0755	0.72983	0.827

MULTIPLE LINEAR REGRESSION

A multiple linear regression was calculated to predict Behaviour Intention to Develop IoT (BI) based on Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Perceived Enjoyment (ENJ) and Attitude Towards using IoT (AT). The R square value of 0.527 indicates that the variation in predicting intention to develop IoT is at 52.7% with combination of attitude towards IoT, perceived usefulness, perceived ease of use, and perceived enjoyment. This shows that there are other factors of 47.3% that can predict the user's intention to develop IoT project afterwards. Table 3 shows that the relationship between PU and BI was statistically significant (β=.408, p<0.01). Meanwhile the relationships between other variables (PEOU, AT, and ENJ) and BI were found to be not significant. Thus, only hypothesis H2 was accepted and hypotheses H1, H3 and H4 were rejected. The full regression formula can be written as:

$$BI = -0.232 + 0.067(PEOU) + 0.497(PU) + 0.248(AT) + 0.182(ENJ). \quad (1)$$

Table 3. Coefficients

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	***t***	**Hypothesis Result**
		B	**Std. Error**	***β***		
DV: BI	Constant	-0.232	0.629	.139	-0.369	
	PEOU	0.067	0.120	.630	0.559	Rejected
	PU	0.497	0.175	.408	2.836**	Accepted
	AT	0.248	0.165	.195	1.501	Rejected
	ENJ	0.182	0.119	.203	1.529	Rejected

R = 0.726 R^2=0.527 ***
Note *p<0.05, **p<0.01

DISCUSSION

The result of this study revealed that only Perceived Usefulness (PU) was significant in predicting user's intention of developing IoT projects in future while perceived ease of use, attitude towards IoT and perceived enjoyment were found to be not significant with PEOU being the least important to user's intention (BI) differing from the finding of Davis which stated that behavioural intention was mutually determined by perceived usefulness and attitude towards using the system (Davis et al., 1989). As this study was conducted among first timer in IoT development, this result was acceptable mainly because the project carried out in the short course participated by the respondents were mostly a new experience for them. Most respondents have only either programming experience or electronic experience making parts of the course challenging as the IoT project involved in building an android app and wiring of electronic components for the IoT device. However, as a whole, PEOU, PU, AT and ENJ does contribute to 52.7% of variation in predicting the user's intention to develop IoT project. With more exposure to IoT development, this result may vary although Davis's TAM was geared more towards exploring user's acceptance of new technology (Davis, 1989).

CONCLUSION, LIMITATION AND FUTURE WORK

The purpose of the current study was to find the relationship between the PEOU, PU, AT and ENJ to user's intention in developing IoT project. The study has shown that respondents acknowledged that IoT technology is beneficial even though the development process was a new experience for them. This finding suggests that, in regards of IoT, users' involvement may not limit to only as an end-user but also have the opportunity to contribute to the growth of IoT technology by developing their own IoT which may facilitate their everyday lives. Further research might investigate other factors which affect user's intention in developing IoT and the impact of demographic data on the behaviour intention as moderators.

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