Determinants of Users Intention to Use IoT

[1]*Nura Muhammad Baba, [2]Ahmad Suhaimi Baharudin, [3]Shehu Hassan Ayagi, [4]Abubakar Muaz Ahmed, [5]Ismail Basiru Sunusi

ABSTRACT--The Internet of things (IoT) is realised as a potentially effective means of integrating multiple technologies to improve the quality of people's life and offering interesting and advantageous new services to individuals. However, it has emerged that consumers' acceptance of IoT is currently low despite its huge economic potentials and impacts, as well as high investment from the private and public sectors. Yet, few studies have investigated the perspectives of the users on IoT. Specifically, only a few empirical researches had examined the determinants of IoT service adoption from the user's perspective and research model were still not fully developed. Hence, there is a dearth of empirical research on IoT adoption in Malaysia. Therefore, this research aims to develop an integrative model of factors influencing users' acceptance of IoT. The research applied an integrated technology acceptance model (TAM). The research hope to provide useful insight into the key driving factors with regard to understanding consumers' behavioural intention to use the IoT.

Keywords-- Internet of things; TAM; User Acceptance; Perceived Usefulness, Privacy.

I.   INTRODUCTION

The advancement of ubiquitous computing technologies, such as wireless networks and mobile devices, has substantially increased the availability of digital information and services in our daily lives and changed how we access and use them. This has led to the rise of the number of people in utilizing the internet. Currently, there are about 3.4 billion internet users' among the 7.4 billion populace of the world [1]. With such an increase in the number of people gaining access to such a global information another big leap forward is in the making which is relatively related to the utilization of the Internet as a global rostrum for permitting communication, computation, dialogue, and coordination between machines and smart objects.

The growth potential of IoT is enormous, with 8.7 billion connected devices in 2012 to 50.1 billion in 2020 [2]. According to Cisco [3], billions of devices will be connected by 2030, with IoT taking half of the share. Having lots of things connected will change our life, and the IoT technologies have the potential to change the world, just as the internet did [4]. Cisco [3] is backing their numbers with a bold statement, saying IoT will change everything, including ourselves. This is because IoT will help humanity take a huge leap in its ability to analysed and distribute data, which can be turned into information, knowledge and ultimately wisdom. The concept will blur the boundary

[1] *School of Computer Science, Universiti Sains Malaysia, Penang, Malaysia, nabnurtrn@gmail.com.

[2] Department of office Technology and Management, Kano State Polytechnic, Kano, Nigeria.

[3]department of Computer Science, Kano State Polytechnic, Kano, Nigeria.

[4]Department of Computer science, Kaduna State University, Kaduna, Nigeria.

[5] Computer Science Department, Faculty of Computing, Federal University Dutse, Jigawa, Nigeria.

between the physical and the digital world and create new relationships among people, things, and businesses. Such increases in the number of connected things, also, had led to the rise of IoT economic value to the world. These opportunities will bring upon widespread impact to the entire marketplace across numerous sectors ranging from manufacturing and transportation to utilities and health care - fuelling gross domestic product (GDP), creating new job opportunities, and bolstering the global economy [5]. The worldwide IoT market spending will grow from $591.7 billion in 2014 to $1.3 trillion in 2019 with a compound annual growth rate of 17% [6]. Furthermore, International Data Corporation (IDC) report that the IoT market size in Asia Pacific will grow from USD 600.3 billion in 2013 to USD 2,602.6 billion in 2020, reporting CAGR of 23.3% [7].

Although, the rapidly increasing number of users has created demand for additional IoT product and services, and new applications have recently been launched in a range of physical domains including shops, hospitals, airports, banks, restaurants, entertainment venues, supermarkets, bus stops, train stations, cafés, convenience stores, taxis, and campuses. Moreover, IoT technologies have been given wide attention, both in the field of research as well as media [5], and had the large number of applications in many fields [8]. However, these goals can only be achieved upon the acceptance of IoT by the user. As such, Chong, Liu [9] assert that organizations benefits can only be achieved upon successful adoption and use of the IoT products by the individual. Furthermore, there's need to determine what factors drive the Malaysian users' to adopt IoT product because currently, the IoT adoption is low [9].

Nevertheless, prior researches has provided a limited understanding of the key drivers in consumer acceptance of new IT technology such as IoT technology. Considering the significance of attracting and retaining IoT users, it is necessary to determine the factor affecting users' intention to adopt IoT products in Malaysia. Therefore, the paper aims to find the factors that affect users' intention to adopt IoT with a view to examines the impacts of these innovation characteristics (perceived usefulness (PU), Perceived ease of use (PEOU), cost, privacy, and security) and users intention to adopt IoT. In doing so, the research will identifies the constructs and propose a model on IoT adoption among Malaysian individuals.

II.   LITERATURE REVIEW

2.1 Overview of IoT

The term internet of things (IoT) was first coined in 1999 by Kevin Ashton, a British technology pioneer who helped develop the concept [10] to describe a system in which objects in the physical world could be connected to the Internet by sensors [11] and referred to it as RFID tagged objects. Nowadays, the IoT has become a popular term for describing scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, and sensors [11], plus everyday items such as food, clothing, furniture, landmarks, monuments, works of art, etc. [12]. Although there is no single contentious definition of IoT, however in 2014, the International Organization for Standardization (ISO) form a group of expert to come up with a common definition of IoT. They define IoT as "An infrastructure of interconnected objects, people, systems and information resources together with intelligent services to allow them to process information of the physical and the virtual world and react" [13]. In Malaysia, the economic potential of IoT based on the report of Gartner (2014) is anticipated to reach RM42.5 billion in 2025 from RM9.5 billion in 2020 [14]. Specifically, Apps, Services, and Analytics will contribute RM7.5 billion in 2020 and reach RM34.0 billion by 2025. The App and Service are the segment where the consumers

come in and takes up 80% of the total share. Currently, the expected economic contribution to the Malaysian economy is worth RM1.78 billion [14].

2.2 *Individual Adoption Theories*

Individual adoption and use of information technologies is one of the most mature streams of information system (IS) research [15]. There have been several models that have been employed to predict behavioural intention to use a system, and consequently, system use [15, 16]. Using these theories, various IT innovations has been investigated, such as IoT [e.g. 17], RFID [e.g. 9], mobile commerce [e.g. 18], and smart watches [e.g. 19].

2.3 *Empirical Studies Related IoT*

The popularity and significance of IoT to both individual and organization had made various scholars to call for the need to investigate the factors affecting IoT technology adoption. Currently, only a few studies have thus been conducted on user adoption, specifically from a Malaysian perspective, very few studies were conducted, and they are mostly conceptual studies. Therefore, it is vital to extend this streams of research by acquiring the empirical result of users' intention to use IoT products. Moreover, the success of new technologies depends on the user acceptance of the products [20]. Specifically, focusing on consumer view point is regarded as one of the pivotal success factors in adoption studies [21].

The author in [22] investigate the determinants of IoT adoption factors in logistics and supply chain management from the perspective of Taiwanese managers. A mixed approach was used to determine the impending factors behind the lack of adoption. Results revealed that cost, benefits and external pressure were significant determinants. Just recently in the food retailing of supply chain, [23] investigated IoT adoption barriers among Indian retailer. Poor internet infrastructure and the lack of government policies emerges as the most significant deterrent to the IoT adoption. Hsu and Lin [24] investigate the factors contributing to IoT service adoption based on Value-based adoption model (VAM) in Taiwan. The author mention that the IoT companies' needs a better understanding of why individuals use their services because diffusion of innovation can be more efficiently achieved through user adoption. Similarly, the same author Hsu and Lin [17], examine the critical factors affecting consumer decisions to adopt IoT from the perspective of network externalities and concern for information privacy. The authors emphasize that more studies are needed because only a few empirical researches had studied the determinants of IoT adoption from the user's perspective. Equally, Mani and Chouk [25] investigated why student resist IoT product. They added that the slow pace of consumer adoption of this innovation is a major disappointment for the IoT industry and thus understanding why consumers' resist the product, is a call for concern. Moreover, Gao and Bai [8] incorporated PBC, trust, SI, and PEJ to the original TAM model to explore user adoption of IoT in China. The author asserts that academic enquiry on consumers behaviour had been generally neglected by earlier studies and therefore called for more studies on factors affecting users' intention to adopt IoT. Several scholars utilize a different approach to study and predict the adoption of IoT by combining many theoretical models. Kowatsch and Maass [26] integrate TAM with privacy calculus to study the critical privacy factors affecting IoT acceptance. They suggested that privacy concern is critical for using IoT services due to their characteristics and the way the data is collected which may pervade consumers' everyday life. Shin [27] proposes quality of experience model from the combine theories of TRA and TPB to explain how users developed quality

experience in the use of IoT. They argued that lack of studies currently exists on user experience and customer satisfaction from the IoT literature.

Liew, Ang [28] conducted a study in Malaysia to identify the influencing features of IoT acceptance by examining the consumer recognitions towards it. They infer that IoT technologies have the convenient for online ticketing services and thus allows users to effortlessly acquire the information they might need. In the Indian region, Mital, Choudhary [29] examined IoT adoption intention based on various theoretical perspectives. The author argued that only few IoT adoption studies were conducted from multiple theoretical approaches and were still limited to few applications. Also, Dong, Chang [30] explore the factors affecting consumers' IoT Intention to use, based on TAM and experience theory. The author mentioned that past researchers had not investigated IoT adoption studies extensively. Meanwhile, Balaji, Roy [31] inspects the consumers' intention to use IoT product in the retail store from the combine TAM model and task technology fit. The authors mention that it is perilous for scholars and retailers to comprehend the acceptance process of IoT technology in the retail industry. In the same vein, [32], consider how trust influences IoT adoption among USA farmers. The influence of trust, risk, and perceived value were investigated. The study shows the importance of applying IoT technology in improving the business profit of farmers. Correspondingly, the work of [33] integrated UTAUT 2 model with Social Influence, price, and IT knowledge to investigate Omanian entrepreneurs acceptance of IoT. The IT knowledge emerges as the most significant determinants of IoT acceptance. Another work in [34] also explore users attitudes towards IoT acceptance through the extended UTAUT model.

Results obtained from 224 participants indicate that the identified factors had strong significant effect on their behavioural intention.

Several international recognised research firm conducted surveys to find the perception of consumers on IoT. For example, in one of the biggest consumers' survey, the 2016 Accenture Digital Consumer Survey carried out a study from 28 different countries involving 28,000 individual consumers'[35]. They investigated the purchase intent of five IoT products including smartwatch. Likewise, the same company Accenture [36] conducted another survey that aims to explore consumer adoption plan and likely barriers of IoT products, now and in the future. The survey suggest that IoT adoption rate can be increase through various promotion offers to consumers.

From the literature reviewed, this study is distinct from many of the researches in a number of ways. This study differs from other studies as it utilised an integrated model of TAM. By combining these two models to include the influences of cost and privacy, the model is designed to give a comprehensive perspective on adoption of IS studies. The model includes many of the antecedents used in the studies mentioned above in a more comprehensive perspective, making it possible to show the relative influences of antecedents related to user perceptions. Equally, the studies reviewed had found certain factors to be important in the adoption of IoT, such as privacy, however, to the authors' best knowledge, no past study has explored these construct in the same model. Hence, this study will serve to narrow the research gap found by examining the determinants of IoT acceptance thru the integrated model of TAM.

III.   RESEARCH MODEL

The research model propose in this study is constructed based on the literature reviewed from the previous chapter. The research model is depicted in Figure 3.1.
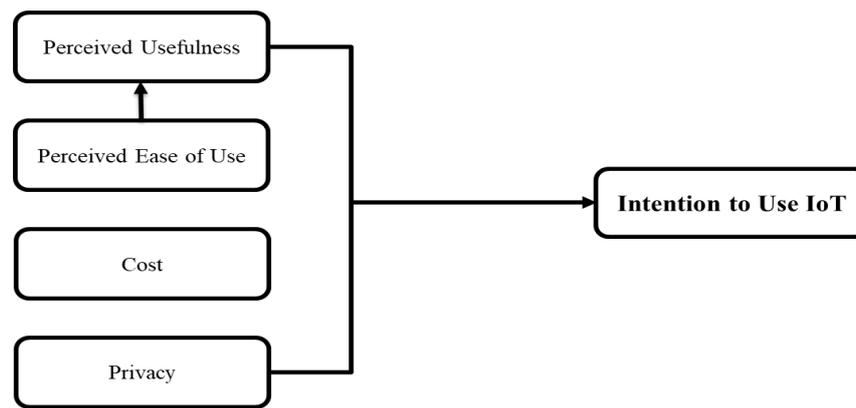
Fig. 1. Research Model

Figure 1: Research modle

3.1 *Relationship between Perceived Usefulness and Intention to Use IoT.*

According to the TAM theory, PU has been hypothesised to positively relate to user adoption behaviour. Many empirical IS studies had found the relationship between PU and intention to use [37-42]. Similarly, from IoT context, several studies also found the relationship between PU and intention to use [e.g. 8, 20, 43, 44-47]. For instance, Liew, Ang [28], in their study of IoT product found PU to influence consumer acceptance.

Applied to IoT, PU relates to the benefits the consumer thinks he or she will take from the future use of a new product in terms of time saving, convenience, access to additional information [25] and improve efficiency and performance [43]. For example, applied to IoT technology in railway section, maintenance staff can receive data from the transponders installed in trains through a mobile reader in their hand to decide whether or not they need maintenance, thereby improving the efficiency of maintenance tasks [8]. Hence, the higher the added value of the IoT, the more the consumer will be inclined to adopt it. Overall, if users feel that the use of IoT, are not useful over their existing technological products, then the users might decide not to use it. Thus, it is expected that perceived usefulness may have positive effect on user's behavioural intention.

3.2 *Relationship Between Perceived Ease of Use and Intention to Use IoT*

Perceived ease of use is one of the core variables of TAM [15, 48]. Several previous studies have state that PEOU is a significant determinant of behavioural intentions to use [8, 49, 50]. TAM stated that PEOU is positively related to intention to use [15, 50]. This relationship was also reported by previous IS studies. For instance, the study of [30, 51], hypotheses PEOU to positively affect adoption intention. However, other scholars such as Di Pietro, Guglielmetti Mugion [52] in their studies on mobile ticketing have shown that PEOU has an indirect effect on behavioural intention through PU. The indirect effect stems from the situation where the easier the technology is to use, the more useful it is perceived to be, thus, the more positive one's attitude and intention toward using the technology [47, 50]. Therefore, building on the core TAM logic and the context above, it is expected that the association between ease of use and intention to use might also be significant.

3.3   Relationship Between Cost and Intention to Use IoT

Cost is one of the inhibiting factors that hinders the acceptance of technology product or services [54-56]. Before users decide to purchase or accept an innovation, the user usually compares the benefits and the cost of the product or service. If the perceived fee exceeds the perceived benefits, the service is seen as expensive, and users will be less likely to adopt it [43]. Keong [38], also asserted that when users perceived that the cost exceeds the benefits of the service, users will decide not to use the technology services like mobile apps.

As a result, the majority of the scholars suggested a negative association between the perceived cost and intention to use while only few scholars hypothesis cost to affect user intention behaviour positively. For example, the study of Kim and Shin [19] on smart watch, Park, Kim [57] on smart home, Abrahão, Moriguchi [58] and Hongxia, Xianhao [59], on m-payment, Chong, Chan [18] on m-commerce all hypothesis cost to negatively affect user's intention. The studies that hypothesis cost as positive to user intention behaviour were those of Yu, Lee [60] on media tablets and that of Kapoor, Dwivedi [61] on interbank m-payment service.

Subsequently, other studies found that users do not consider the cost of the product as long as the products bring benefits and value to the user [e.g. 62, 63]. For example, the studies on mobile payment of Oliveira, Thomas [64], Phonthanukitithaworn, Sellitto [65] and Teo, Tan [66] all found that cost did not affect consumers intention. Equally, cost did not affect consumer acceptance decision in other domains such as NFC [67], smart meter acceptance [68], stickiness intention [69], m-entertainment [39], multimedia message service [40]. This suggests that the higher the costs of using new technology like IoT products and or services, the less it will be accepted by the user. Thus, in view of these contradicting findings, this study infer that cost may have negative impact on users intention to use IoT.

3.4   Relationship Between Privacy and Intention to Use IoT

Privacy concern is one of the biggest challenges that hinder the used of new technology product especially those that involve the use and sharing of data. Users are generally concern about how their data were gathered secretly and constantly without their permission [70]. These privacy issues raised by the technology are amongst the factors that slow down the adoption of technology product [47]. Several scholars have highlighted the importance of privacy concerns related to consumers' behaviour studies. Researchers believe that these concerns will increase with the development of smart products [25, 71] and smart services [17, 72]. As these IoT products and or services interact daily with the end user and they encompasses ubiquity, invisibility, pervasiveness, and invasiveness as their characteristic [71]. These products also gathered and managed sensitive information and or confidential data like location based data, financial and personal information [73]. As such, users may be concerned that IoT providers collect personal data without prior notice. Previous studies have empirically shown that perceived privacy has a negative impact on user adoption behaviour [43, 47, 68, 74-76]. For instance, in RFID adoption studies, privacy concern was shown to negatively affect nurses and physicians adoption behaviour [47].

Smart products have the ability to collect information automatically. When the user uses IoT products like smart home appliance certain information such as individual movement, energy use and bills or buying history are being gathered without their consent [77]. Firms should inform users about how collected information will be used prior to collection. Such information will allow consumers to better assess the risks of disclosing personal data [17] and might reduce the difficulties of users experienced in knowing where and how their information is stored

and who is authorised to access and use them [25]. Consumers who are concerned about their privacy might deter to use IoT product or services. In view of these facts, this study infer that privacy may have a negative impact on user intention to use IoT.

IV.   CONCLUSION

The study aims to find the factors that affects Malaysian individuals' intention to use IoT. Factors were identified through rigorous literature review which were link through the lens of TAM. The study will have employed a quantitative survey to test the proposed study hypotheses through structural equation model technique. Recommendation will be given to the relevant stake holders based on the findings of the study.

V.   ACKNOWLEDGEMENT

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