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Adoption of IoT Smart Homes in Jordan: The Role of Trust and IT Knowledge

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Abstract

Internet of Things (IoT) is a new technology and it has been used in several disciplines in developed countries. In developing countries such as Jordan, the IoT smart home is provided by several companies, however, the adoption of IoT smart home has been examined in few studies. The purpose of this study is to examine the adoption of IoT smart home in Jordan. Technology-Organization-Environment (TOE) framework and Social Exchange Theory have been used to develop the conceptual model of this study. The study proposes that technological context (security, privacy, and availability) affect the behavioural intention (BI) to use IoT smart home. The study proposed that BI will have a positive effect on adopting IoT smart home. Trust in service provider was proposed as a mediator and IT knowledge as a moderator between technological context and BI of IoT smart home. The population of this study are executives in listed and non-listed companies. The study uses the random sampling. The data was collected using a questionnaire. A total of 315 responses were collected. The data was analysed using Smart PLS. The findings of hypotheses testing showed that the effect of technological context is positive and significant on BI to use IoT smart home. In addition, BI to use IoT smart home have significant effect on the adoption of IoT. Trust partially mediated the effect of technological context on the BI to use IoT smart home. However, IT knowledge did not moderate the effect of technological context on BI to use IoT smart home. Decision makers are advised to focus on the technological aspect and improve the trust in service providers.

1. Introduction

Internet of Things (IoT) aims to connect anything and anyone at any time and any place, and it gives rise to new innovative applications and services [1]–[3]. Supporters of the usage of IoT described it as a new industrial revolution that will increase productivity and keep the population healthier, enhance the public transport and reduce the energy consumption as well as to deal with the issue of climate changes, security and safety and to achieve more sustainable production and consumption [4]–[7]. IoT is defined as a system that integrates physical objects, software and hardware to interact with each other [8]. IoT was deployed in several area such as production, manufacturing, healthcare, and other fields [9]–[13]. The usage of IoT in smart home is less compared with other fields [14]–[16].

Researchers indicate that the market for smart home was expected to grow rapidly. However, in contrast to optimistic expectations for future market growth, the smart home market has appeared to decline and remains at an early market stage [17]. The main reasons behind this slow growth is related to the issue of users' adoption as well as their level of information technology (IT) knowledge and the privacy and security issues [8], [18], [19]. Research into smart homes were dominated by developed countries while in less developed countries, the technology of IoT smart homes is provided by local companies. However, the adoption rate is low due to several factors that are related to the knowledge and awareness about IoT smart homes as well as the technological issues such as security, privacy, and availability [20].

In Jordan, several companies provide the services of IoT smart homes. However, the adoption rate of this technology is low among Jordanian and this mainly due to concerns over the privacy, security, cost, trust, and IT knowledge as well as the attitude toward IoT smart homes [20]. However, the market of IoT smart home is projected to grow in Jordan and there is a need to examine the technological predictors of the adoption of IoT smart homes [21]. Therefore, this study

examines the effect of technological factors and the mediating role of trust as well as the moderating role of IT knowledge in the context of adopting IoT smart homes.

2. Literature Review

This section provides a brief discussion of IoT smart homes, theoretical framework, and the conceptual framework development.

2.1. IoT Smart Home

IoT smart home is a new technology that aims to enhance the quality of living for the individual and household that are using the technology. The technology is based on the connection of all the devices of a home to turn it to smart and remote controllable by the users. This includes home appliances e-health, entertainment, communications, assisted living, security, energy efficiency, and convenience [17]. Researchers noticed that a smart home is characterized by four key aspects: a communication network through which different devices talk to each other; intelligent controls to manage the system; sensors that collect information; and smart features, which respond to information from sensors or user instructions as well as the system provider [17], [22], [23].

2.2 Theoretical Framework

TOE is considered a multi perspective framework [24] [25]. Since the adoption is related to individual, the environmental and organizational factors are excluded. Additional variables that are considered contextual and important for the context of IoT smart home is the trust in service provides. This variable can be covered by the social exchange theory.

2.3 Framework Development

Based on TOE and SET, this study proposed that the effect of technological context on BI is positive. This effect is expected to be mediated by trust in the service provider and moderated by IT knowledge. BI is also expected to affect the adoption of IoT smart homes in Jordan. Figure 1 shows the conceptual framework of this study.

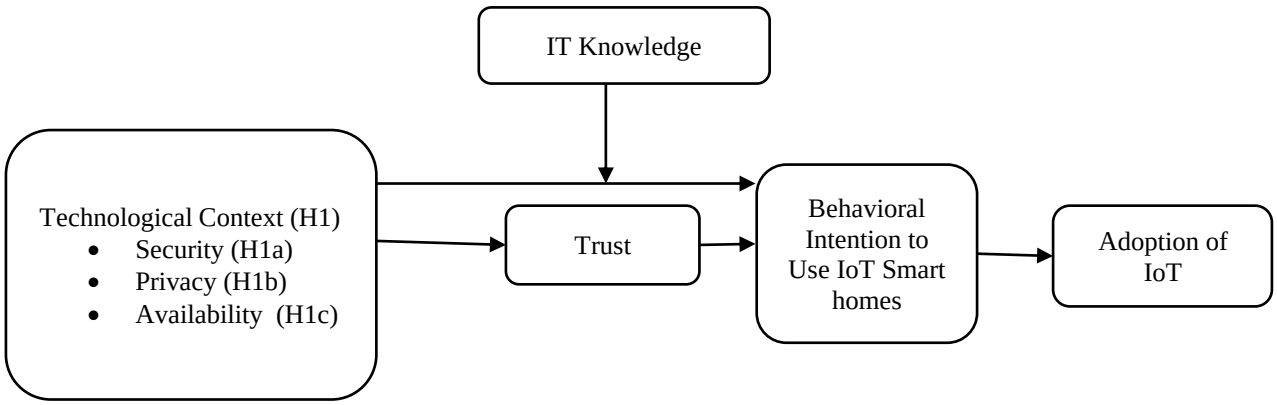

Figure 1: Conceptual Framework

2.4 Technological Context Factors and Behavioral Intention to Use IoT

The technological context factors includes the security, privacy, and availability. Technological context are core components of TOE. Several studies examined their effects on various technology adoption. In IoT context, [26] found that technology dimension has important and positive effect on the adoption of IoT smart farm in Korea. In the study of [27] in Spain found that technological context has a positive significant effect on the adoption of IoT by SMEs. Thus, in this study, it is expected that technological context affect positively the behavioural intention to use IoT smart home by Jordanian. Accordingly, it is hypothesized:

H1: Technological context affect positively BI to use IoT smart homes.

2.4.1 Security

Security is a major issue for the adoption of technology in general and IoT smart homes in particular. Several previous studies pointed out that security is a critical factors for the adoption of IoT [28]–[30]. Pinochet et al. [31] found that security of IoT is important for the adoption and repurchase intention of IoT. Similarly, in the study of [32], security affect significantly the resistance to smart services. In US, the study of [33] found that security is important for the ownership of IoT smart homes. Accordingly, it is hypothesized:

H1a: Security has a significant effect on BI to use IoT smart homes.

2.4.2 Privacy and Behavioral Intention

In the context of IoT, privacy concern are critical regarding the data collection using the technology of IoT [28]. Hsu and Lin [34] indicated that privacy affect the collection and the use of private data and it is a main contributor to the adoption of IoT. Dong et al. [35] found that privacy affect the intention to use IoT smart homes in China. Findings of the study of [30] also indicate that privacy is critical for the adoption of IoT. [36] considered privacy as the most important factor for the adoption of IoT smart homes in South Korea. Accordingly, it is hypothesized:

H1b: Privacy has a significant effect on the BI to use IoT smart home.

2.4.3 Availability and Behavioral Intention

Tornatzky and Fleischer [37] developed the TOE model and considered availability of the technology as a technological factor. Mashal and Shuhaiber [20] also found that availability of IoT smart home is essential for the adoption of the technology. In the study of [27] among SMEs in Spain found that availability is important determinant of the adoption of IoT by SMEs. In this study, the following is hypothesized:

H2c: Availability has a significant effect on BI to use IoT smart homes.

2.5 Behavioral Intention and Adoption of IoT

Established theories in the literature of technology adoption linked the behavioural intention to use behaviour [38]–[40]. Most of the previous studies linked the BI to the use behaviour and found positive association between the two variables [41]–[43]. In the study of [35], intention to use affected positively the actual use of IoT smart homes. Therefore, in this study, it is hypothesized as:

H2: BI has a significant effect on the adoption of IoT smart home.

2.6 Mediating Role of Trust

The perception about the service providers as trustworthy, honest, and work in the interest of the user enhanced trust and increased the adoption of technology [44]. Based on a typology on trust role in the adoption of new technology, [45] concluded that trust received less attention in the context of technology adoption and the variable trust played a mediating role between success factor of adoption and usage intentions. Social Exchange Theory (SET) proposed trust as an important factor that affect the intention of individual to perform an action. A study of [46] used the theory of SET to explain the role of trust in a group intention to buy via online environment. The study found that trust was one of the most important factors to affect the behavioural intention and the satisfaction of users in online buying context. Other researchers examined the trust effect on the purchase intention in e-commerce study and found that trust was the main predictor of purchase intention [47]. Lian [48] tested a mediating role of trust in cloud adoption. The author found that trust mediated the effect of a perceived quality on satisfaction about cloud adoption by users in Taiwan. Li et al. [49] found that trust mediated the effect of technological aspects and environmental aspects on the cloud transformation intention. Accordingly, the following is hypothesized:

H3: Trust mediates the effect of technological context on BI to use IoT smart home in Jordan.

2.6 Moderating Effect of IT knowledge

IT knowledge is a critical factor for the adoption of IoT smart homes. In the study of [26], IT knowledge was considered as an important factor for the adoption of IoT in farming industry in South Korea. Kayali et al. [50] found that IT knowledge moderated the effect of individual factors on BI to use cloud computing e-learning. In the context of IoT, the study of [35] examined the role of experience and education as moderating variables and found that the high level of education and experience is critical for enhancing the adoption of IoT smart homes in China. Accordingly, in this study,

it is expected that high IT knowledge of controlling the IoT smart homes will lead to adopt the IoT smart homes. Thus, it is hypothesized:

H4: IT knowledge moderates the effect of technological context on the adoption of IoT smart homes.

3. Research Methodology

This study is quantitative, and it uses a questionnaire as a tool for data collection. The questionnaire is the best tool to collect data in a short time (Sekaran & Bougie 2016; Zikmund et al. 2013). The population of this study are the high-income individual in Jordan. According to Amman Stock Exchange, there are almost 192 public listed companies. It is estimated that 10 of the employee are in the executive level with earning larger than JD 12,000. In addition, family-owned business is high in Jordan. Almost there are 500 companies that are owned by families. This makes the population of this study (1920 (executives in listed companies)+ 5000 (executives in family-owned companies). Thus, the population of this study is 6920 high income individuals. This study uses random sampling techniques. This is because the study examine the adoption of executive levels which have to large extent similar income and similar live style. Based on the population of this study which is 6,920, the sample size using the formula of [53] is 364 respondents. Considering the non-response and the outliers, the sample size is doubled. This is in line with the suggestions of [54]. Thus, the questionnaires are distributed to 728 respondents.

This study is using a questionnaire, the questionnaire was adopted from several sources. Security (3 items) and privacy (4 items) were adopted from [55]. Trust (4 items) was adopted from [20], IT knowledge was adopted from [26], availability (4 items) was adopted from [56], behavioural intention (5 items) was adopted from [57], [58], user behaviour (3 items) was adopted from [38], [59]. The English and Arabic version of questionnaire was validated by three experts and a pilot study was conducted prior to field data collection. A total of 724 questionnaires were sent to respondents using the database of listed and family-owned companies in Jordan. Follow up and reminder were used to increase the response rate, and this has resulted in 341 responses. A total of 11 were removed due to missing value and 15 due to outliers. Total valid, complete, and usable responses were 315. The data is normally distributed and no collinearity issues among the variables.

4. Findings

4.1 Profile of the Respondents

The respondents of this study included 315. The age of the majority ranged between 41-50 years (80.3%) with males are dominating the sample (65.1%) with education of bachelor's degree (76.2%). The respondents have used the IoT application and have adequate experience of using IoT applications such as Smart Home (16.2%), manufacturing (42.5%), healthcare IoT (27.9%).

4.2 Measurement model

The measurement model of this study was examined by checking the factor loading, validities as well as the reliabilities of the measurements. The findings showed that some of the items were removed. For instance, item 3 from trust was removed as well as one item from privacy, one item from BI and one from IT knowledge. The Cronbach's Alpha (CA) as shown in Table 1 is greater than 0.70. Similarly, the Composite Reliability (CR) is greater than 0.70 and average variance extracted (AVE) is greater than 0.50. These values are in line with the suggestion of statisticians such as [60]. For the discriminant validity is fulfilled since the root square of AVE is greater than the cross loading as shown in Table 1.

Table 1: Reliabilities and Validities of the Measurement Model

	CA	CR	AVE								
Availability	0.908	0.936	0.784	0.88							
Behavioural Intention	0.879	0.925	0.805	0.42	0.89						
IT Knowledge	0.967	0.975	0.906	0.11	0.23	0.95					
Privacy	0.777	0.872	0.697	0.42	0.55	0.03	0.83				
Security	0.886	0.929	0.814	0.39	0.47	0.07	0.51	0.90			
Technological Context	0.849	0.884	0.539	0.40	0.60	0.07	0.37	0.58	0.86		
Trust	0.865	0.917	0.788	0.28	0.40	0.12	0.27	0.27	0.35	0.88	
Use Behaviour	0.825	0.897	0.744	0.25	0.63	0.65	0.33	0.33	0.38	0.26	0.86

4.3 Structural Model and Hypotheses Testing

The structural model was evaluated by examining the values of R-square (R^2), F-square (F^2), and predictive relevance as well as the path coefficient. The R-square of the model is 0.50 indicating that a total of 50% of IoT adoption can be explained by technological context. The F-square for all paths are medium while the predictive relevance is greater than zero. These values are acceptable based on the suggestions of [60]. The structural model of the study is given in Figure 2.

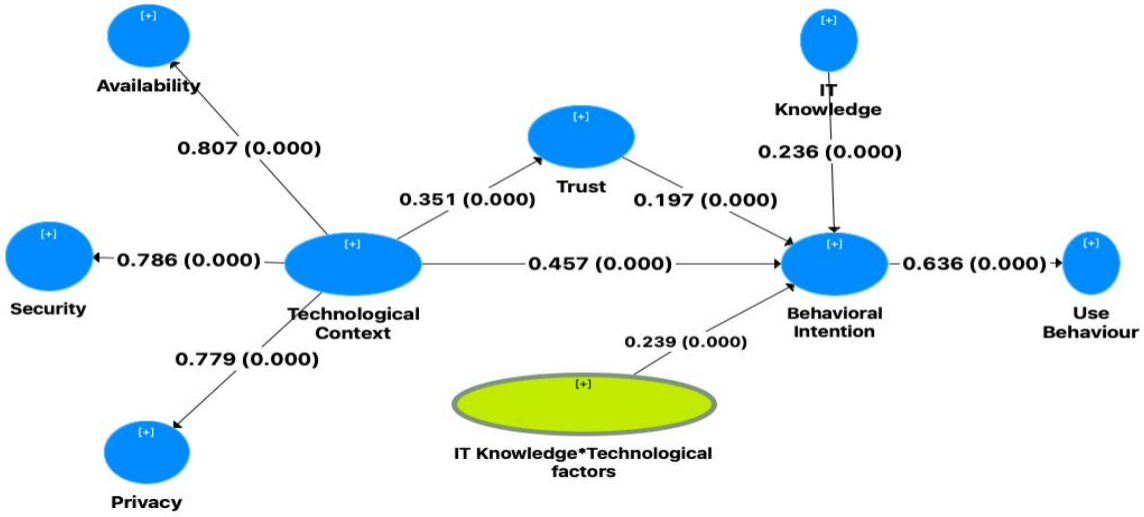

Figure 1: Structrual Model

Path coefficient of the model is shown in Table 2. It shows the path coefficient (B), standard deviation (STDEV), T-values (T), and P-values (P).

Table 2: Path Coefficient and Result of Hypotheses

H	Path coefficient	B	STDEV	T	P	R2	F2
H1	Technological Context -> Behavioral Intention	0.457	0.046	9.830	0.000	0.50	.34
H1a	Security -> Behavioral Intention	0.184	0.049	3.730	0.000		
H1b	Privacy -> Behavioral Intention	0.405	0.056	7.179	0.000		
H1c	Availability -> Behavioral Intention	0.159	0.059	2.736	0.006		
H2	Behavioural Intention -> Use Behaviour	0.636	0.049	13.108	0.000	0.40	.68
H3	Technological Context -> Trust	0.351	0.054	6.508	0.000		.14
	Trust -> Behavioral Intention	0.197	0.044	4.449	0.000		.07
	Technological Context-> trust-> behavioral intention	0.069	0.019	3.717	0.000		
H4	IT Knowledge -> Behavioural Intention	0.236	0.050	4.741	0.000		.10
	IT Knowledge*Technological factors -> Behavioural Intention	0.239	0.039	6.123	0.000		.12

The result of hypotheses testing showed that the effect of technological context on the BI is positive and significant. Therefore, H1 is supported. For the H1a, H1b, H1c, the findings of hypotheses testing in Table 2 showed that the effect of security on BI (H1a) as well as the effect of privacy on BI (H1b), and the effect of availability on BI (H1c) are significant. This indicates that H1a, H1b, and H1c are supported. For H2, it aimed to examine the effect of BI on use behaviour and found that the effect is positive and significant. Therefore, H2 is supported.

H3 proposed that trust mediates the effect of technological factors on BI toward using IoT smart homes. The findings in Table 2 shows that in comparison between the direct and indirect effect, there are mediating role of trust between technological factors and BI. For H4, the results of testing the hypothesis indicated that the interaction between technological context and IT knowledge (IT knowledge*technological factors) is positive and significant indicating that the moderation occurred and confirmed. Therefore, H4 is supported.

5. Discussion

This study aimed to examine the effect of technological context on the adoption of IoT smart homes in Jordan. The study operationalized technological factors to include security, privacy, and availability. The study also examined the mediating role of trust and the moderating role of IT knowledge. The findings showed that technological context are critical determinant of the IoT smart home adoption in Jordan. In addition, the findings showed that the effect of privacy is greater than security and availability and this could be due to the notion that having smart home applications in the home might expose the privacy of the users. Thus, it is critical to have confidential IoT smart homes. This finding is in agreement with the findings of several previous studies that found the effect of technological context as well as its components such as security, privacy and availability significant [26] [27] [28]–[30] [31] [32] [33] [34] [35] [36].

In addition, the findings showed that trust mediated the effect of technological factors on the adoption of IoT smart homes. This indicates that trusting the service provider is critical to enhance the adoption of IoT smart homes. The mediating role of trust indicates that part of the effect of technological context on the IoT smart home can be explained by trust. This finding is consistent with the findings of previous studies that found trust as a mediating variable between technological context and technology adoption [47] [48] [49]. The study also examined the moderating effect of IT knowledge. The findings showed that IT knowledge moderated the effect of technological context on adoption of IoT smart homes. The increase in the level of IT knowledge as a moderator will have a positive impact on the effect of technological context on adoption of IoT smart homes in Jordan.

6. Implications

This study has contributed to the literature in developing countries and in smart home IoT adoption. The study has identified the effect of technological context using a combination of TOE and SET. The study have examined the mediating role of trust and the moderating role of IT knowledge. The study also managed to explain large percentage of the adoption of IoT smart home in Jordan. As a suggestion for decision makers, they are advised to enhance the privacy of IoT smart home. Privacy was found the most critical factors among the technological aspect, and it can determine to a large degree the intention of the users toward the IoT smart home. The study also found that the effect of security and availability are also critical. Therefore, decision makers in Jordan are advised to establish a secure IoT smart home. Availability is also critical and decision makers are advised to make sure that the IoT application are available from anywhere at any time.

Trust was found to mediate the effect of technological context on adoption of IoT smart home. Decision maker are advised to ensure that the service provider of IoT is trustworthy and put in place strict policy for any breach of trust. The IT knowledge is also important and decision makers have to create workshops and courses to teach users how to use the IoT smart homes. IT knowledge can increase the number of users.

7. Conclusion

This study has been conducted to examine the effect of technological context on IoT smart home adoption. The study examines the mediating role of trust and the moderating role of IT knowledge. The findings showed that privacy, security, and availability are critical technological context factors and affected positively the IoT smart homes adoption. The study also found that trust mediated the effect of technological context on the adoption of IoT smart home while IT knowledge moderated this effect. The decision makers were advised to enhance the privacy and create a trusting relationship between users and service providers. The study is limited to executive level employees working in listed and non-listed companies in Jordan. The study has been conducted in Jordan and examined the IoT smart homes. Future studies are recommended to examine the adoption of IoT in other area such as healthcare, manufacturing, and education. Further studies are recommended to be conducted on smart home in different countries using different type of respondents such as employees in the middle level of management or professional employees such as lawyers, engineers, and doctors.

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