A Model Of Factors Influencing Users' Adoption Of Internet Of Things Services: A Case Study Of Iraqi Educational Institutions

IOP Conf. Series: Materials Science and Engineering **769** (2020) 012006 doi:10.1088/1757-899X/769/1/012006

A Model Of Factors Influencing Users' Adoption Of Internet Of Things Services: A Case Study Of Iraqi Educational Institutions

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Abstract. In the revolution of information technology, the appearance of Internet of things (IoT) is considered a significant evolution that can enhance the efficiency and prosperity of daily activities. In this context, a few people are aware of the important benefits that can be gained from using IoT services. Generally, previous researchers have studied the technical aspects of IoT, such as architectural dimensions, models, wireless sensor networks and attribute-based signature. The aim of this study is to identify the factors that influence users' adoption of IoT services at an educational institution in Iraq. The stratified sampling techniques were used to collect data from 221 users (students and lecturers) at university of Basra. Meanwhile, results corroborate that social influence is the most important factor in relation to the behavioral intention (BI) to use IoT services follow by effort expectancy, security and, performance expectancy. Facilitating conditions and BI have an effective influence on the use behavior of IoT services. Ultimately, contributions and recommendations were demonstrated.

Keywords: Internet of things, Higher Education Institutions, UTAUT, Security, TAM, DOI

1. Introduction

The appearance of (IoT) was introduced by Ashton in 1999 [1].It is a networking of electronic connection that enables the gathering and transferring of information amongst physical objects [2].Moreover, it refers to the outcomes of development, such as new IP protocol versions, broadband and combination of nanotechnology with many electronic devices (i.e. mobile phones), in the telecommunication field. Consequently, IoT is created on the basis of the idea of simultaneously integrating electronic devices that are connected within a network with other users [3]. Ultimately, IoT services are growing intensively when the devices of users, enterprises and stakeholders are connected to the Internet network [4].

Despite the increasing number of IoT services and advanced features that IoT offers, such as the maximum connection efficiency of users worldwide, a few people are aware about the important benefits of using these services. In addition, people have a slight perception regarding their motivation to continue using IoT services in daily life. In fact, many people are apprehensive about these services due to serious concerns, such as security breach [4].

The majority of the literature has covered the technical aspects of IoT usage. Moreover, previous studies have focused on architectural dimensions[5], wireless sensor network and attribute-based signature[6].Meanwhile, other relevant research has discussed other issues, such as descriptions,

concepts, business models, opportunities and challenges [5],[7],[8],[9].Finally, previous studies have neglected the aspect of IoT users and their perception about the technology.

This research aims to discover the factors that influence the adoption of IoT services at higher institutions in Iraq. The technology acceptance model (TAM) was applied in order to evaluate the perception of users regarding the adoption of IoT[1]. Conversely, the acceptance unified theory and use of technology (UTAUT) was confirmed to be influential and capable in interpreting the difference in the acceptance of technology more than TAM and previous models[10],[11].They also corroborated that UTAUT model is unlike the TAM model was originally proposed to investigate the user adoption of technology [12],[13],[10]. However, despite the high explanatory power, UTAUT conceptualization was argued due to the absence of security factors. Current researches have confirmed the importance of security factors in the decision of adoption technology [14], [15].

Literary, developed countries captured the majority of the studies on IoT services .This study investigates the adoption of IoT services by users at educational institutions in Iraq, which is the perfect place for IoT. In addition, extensive international and domestic investment and economic growth coupled with limited legacy infrastructure set the stage for a digital revolution in the Iraq. The application of the technology in the country could help in minimising waste resources and increase the efficiency of educational institutions. Thus, this study will be conducted in educational institutions in Iraq to examine the ability of these organisations to apply the technology and utilise its benefits.

The present study conducted to discover the factors that influence the adoption of IoT services by users at higher educational institutions in Iraq. Meanwhile, this research is structured as follows. The neglected areas, discussions that demonstrated in the literature review, as well as the proposed aims that presented and highlighted in the Introduction section. And the third section explains the research models and the development of hypothesis.

Furthermore, the fourth part discusses the research methodology, and the fifth part demonstrates and discusses the results of this study. Ultimately, the last section derives the conclusion, limitations and, directions for advanced research.

2. Review of literature

2.1 Iot

Formulation of IoT depends on the concept of the integration of devices with embedded sensors, which permit them to connect simultaneously via an Internet interface. Although traditional Internet services connect people through communication and information sharing, IoT connection requires a vast network to enable communication amongst objects, machines and internal sensors. Conceptually, IoT can be defined as the process of aggregating network capacities, intelligence and smart objects that interact autonomously with users. Technically, it is composed of three components, namely, hardware, infrastructure and application and services [3],[16].Hence, IoT consists of a huge web that is created from physical objects, such as sensors and machines, that establishes standard communication between them and within remote databases [9].Furthermore, IoT provides users with the ability to manage and control their electrical machines, such as heating and lighting, security and lighting systems from anywhere through their computers and mobile devices [5].Ultimately, IoT must be distinguished from traditional Internet services. That is, IoT has the ability to remotely interact with machines and objects instead of merely providing online services.

2.2 Iot In educational institutions

The interface between IoT and education can be traced back to 1999 when the Auto-ID Centre of the Massachusetts Institute of Technology first proposed the IoT concept. IoT has brought a huge transformation to the educational community. In the era of rapid technology development, top management and lecturers in educational institutions are challenged to change their thought processes on teaching and educating the new generations of students. Moreover, pressure is increased on the

education institutions to upgrade their educational methods and respond to the technological changes in the marketplace. In this essence and through IoT, educational institutions should redirect its strategy to enhance teaching, learning and researching activities. In addition, IoT can motivate students to be responsive and interactive with lecturers in such a manner that enables lecturers to obtain the best understanding and communicating space with students [17].For instance, IoT can facilitate an interactive English teaching course that teaches students based on individual differences and enhance their capacities to be creative

2.3 UTAUT

The UTAUT model was developed to accumulate previous interrelated models, such as the motivational model (MM),TAM, social cognitive theory and , diffusion of innovation theory (DOI) [10].The UTAUT is composed of six main factors, namely, performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FCs), behavioural intention (BI) and use behaviour. In addition, The UTAUT contains four main moderators which are age, experience, voluntariness and gender. Table 1 provides the main factors of the UTAUT and previous models from which these factors are derived.

Table 1. Main factors of the UTAUT

Factor	Previous Models
Performance Expectancy	Perceived usefulness (TAM/TAM2/ C-TAM-TPV) extrinsic motivation (MM); job-fit (MPCU); Relative Advantage (DOI).
Effort expectancy	Perceived easy to use (TAM/TAM2); Complexity (MPCU/DOI).
Social influence	Subjective norm (TRA, TAM2, TPD/DTPB, C-TAM-TPD); Social factors (MPCU); Image (DOI).
Facilitating Conditions	Perceived behavioral control (TPB/DTPE, C-TAM-TPB); Facilitating conditions (MPCU); Compatibility (DOI).

Previous studies have described the UTAUT as a new theoretical model, which strengthens the inadequacies of previous models[12],[14].The exploratory power of the UTAUT model, which can reach up to 70%, is higher than those of previous models [12],[18],[19].

The majority of previous studies have used the TAM or DOI to discover factors that influence the adoption of IoT[1],[9].The literature focuses less on the use of the UTAUT model to determine the factors that influence the adoption of IoT. Moreover, the UTAUT was developed to assess individual acceptance of a new technology. It was applied in many areas, such as social networking sites[20] near field communication for mobile devices and services [21]and cloud computing by universities[14]. However, the use of the model in IoT studies remains limited. Ultimately, this research used the UTAUT model interrelated with security factor.

3. Conceptual model And research hypotheses

3.1 Conceptual model

The UTAUT model deploys in this research as conceptual model due to its main role to investigate user adoption of technology. This research also incorporates the factor security (SEC). Issues in SEC are crucial for ensuring the successful adoption of an appropriate IoT. In addition, researchers criticised the UTAUT and TAM because they excluded SEC from their models [22],[23]. Figure 1 presents the conceptual model of this study.

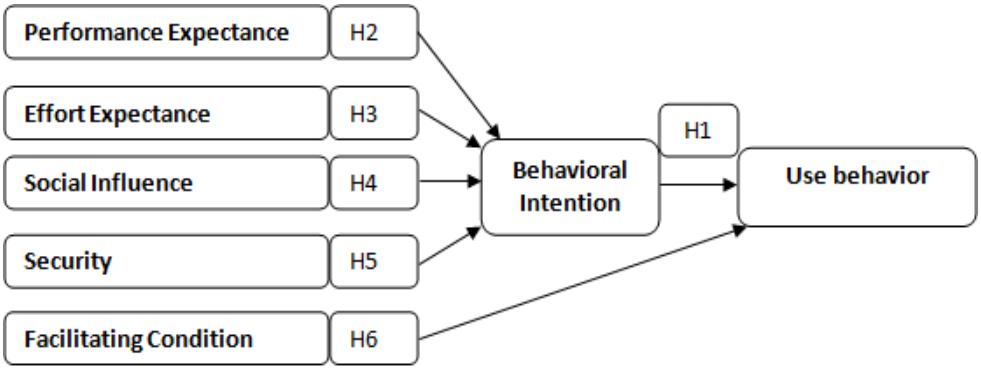

Figure 1. Conceptual model for user adoption

3.2 Research hypotheses

BI and use behavior are the dependent factors of this research. The UTAUT model indicated a direct connection between BI and use behaviour [10].Meanwhile, [9] corroborated that BI strongly influences the real usage of IoT services. Regarding this research, BI is predicted to influence the use behaviour of IoT. Thus, the following can be hypothesised:

H1: BI exerts appositive influence on the usage behaviour of IoT services.

The first factor of the UTAUT is PE, which is also a critical factor for user adoption. In this study, the PE factor has important role in DOI as relative advantage and has the same important in TAM as perceived usefulness [10],[24],[25]. In addition, it represents the users' thought process about how a specific technology improves its performance upon use. For instance, IoT technologies can save time and effort and speed up the processes in retail stores. Users positively perceive these improvements in services. Apparently, IoT technologies enhance adoption rates by enhancing services in users' ordinary life. Empirically, studies in the IoT field have proved that PE influences users' BI to adopt IoT technology [1],[26]. In this study, users' intention to adopt IoT services is expected to increase if they realised the advantages of using this technology. Hence, we propose the following hypothesis.

H2: PE has a positive influence of users' BI to use IoT services.

The EE factor has important role in DOI as complexity and has the same important role in TAM as perceived ease of use [10],[25]. It represents users' perceived efforts when they apply IoT technologies. To encourage users to adopt IoT services and technologies, users must perceive that IoT services are easy to apply without any bold obstacles and efforts. Further, studies have proved that the perceived ease of use in the TAM and UTAUT positively influences the BI of users to adopt the IT technology [14],[24],[27]. Hence, we propose the following hypothesis:

H3: EE has a positive influence on users' BI to use IoT services.

The social aspect plays an important role in how decisions are formulated and executed. The acceptance of any innovative technology is an essential factor to assess [9]. Generally, when a new technology is initially used, most users lack trusted information about this technology. Therefore, users rely on the social network context, such as opinions of friends, family and classmates[24].Therefore, users' intention to adopt any technology is influenced by social impact, judgement and evaluations from other people. For instance, SI is argued to exert an important impact on the privacy information of users[9]. In terms of IoT technology, many researchers have argued that SI has a significant impact on users' acceptance of IoT technology[1],[24].In this study, the user intention to adopt the IoT services is predicted to be influenced by users who have previously used this technology. Hence, we propose the following hypothesis:

H4: SI has a positive impact on BI of user to use IoT services.

The UTAUT was criticised for not contain factors like SEC in the conceptualization model [14],[19]. Recent researches argued that security factor have strong impact on users decisions to adopt IoT services [7],[8].Security is the degree of data confidentiality, authentication and access control within an IoT network[8]. Generally , security factor play an important role in information systems field .Particularly, security also play the same important role in the IoT services domain.[28].Consequently, several researchers have conclude same results and affirmed the importance of security for the adoption of IoT [7],[8],[9]. Therefore, the present study assumes that the SEC factor exerts a positive influence on the BI to adopt IoT services. Thus, we propose the following hypothesis:

H5: High SEC has a positive influence on users' BI to use IoT services.

The FC factor proved to have a direct influence on user behaviour[10]. FCs is described as certain conditions for users to adapt technology [12]. Thus, FCs represents the required resources, capability and relevant information that users must acquire and perform successful behaviour. Users require having essential skills to the IoT services and technology. In addition, FCs has the same role as FCs in (MPCU)[10], and compatibility in DOI. Therefore, on the basis of the above discussion, the present study assumes that the FC factor exerts a positive influence on user behaviour to adopt IoT services. Thus, we propose the following hypothesis:

H6: FCs has a positive influence on the use behaviour of IoT services.

The above-mentioned hypotheses were proved empirically to discover factors that influence users' acceptance of IoT services. Thus, the current research deploys specific questionnaire items to confirm the proposed model hypotheses and factors that could affect the acceptance of user to adapt IoT services. Table 2 illustrates the selected questionnaire items that could be used to prove the proposed hypotheses (H1– H6).

Table 2. Questionnaire items based on model factors

Factors\Authors	**Items**	**Questions**
Performance Expectancy [9] ,[29]	5	Using IoT services improves my work/life performance. Using IoT services helps me obtain information that is useful for my work/life. Using IoT services enhances my work/life efficiency. Using IoT services enables me to accomplish my work/life more quickly. *Overall, using IoT services creates significant learning spaces.
EE [14]	5	Using IoT services is easy. Learning to use IoT services is easy. Using IoT services is not a burden during transition. Using IoT services does not require considerable mental efforts. Overall, I find doing my day-to-day work/study easy with IoT services.
SI [14]	6	I use IoT services because my friends use IoT services. I use IoT services because my family members use IoT services. My professors have been supportive of using IoT services. I use IoT services because the mass media

		encourages the use of IoT services. Word-of-mouth stimulates me to use IoT services. The university has supported the use of IoT services.
FCs [14]	5	I have the hardware and software for using IoT services. I have the skills and knowledge for using IoT services. When I have problems using IoT services, someone can help me solve them. I always have electricity supply to use IoT services. I have Internet connection to utilize IoT services.
SEC [9],[14]	5	Using IoT services is associated with extreme uncertainty. Using IoT services service would lead to a loss of SEC. Service stability is a determinant of using IoT services. My decision to use IoT services exposes me to security concerns. Overall, considerable security is involved in using IoT services.
BI [9],[14]	4	I hope to use IoT services. I intend to switch from the traditional use of service to IoT services. I intend to increase my use of IoT services in the near future. I intend to recommend my friends/family members to use IoT services in the future.
Use Behaviour [14]	5	Managing my devices using IoT services is easy. *I am regularly using IoT services to control devices. *I am regularly using IoT services to manage devices. I rely on IoT services to control my devices. I have used IoT services in my university.

4. Research methodology

In this study, population refers to all users of IoT services in Basra University, which is composed of33,567 students and 2,848 academic staff according to the university website[30]. Students pertain to individuals who are pursuing diplomas and Bachelor, Masters and PhD degrees, and academic staff refers to the lecturers.

A sample refers to a group that is selected from the population for representation [31]. Proportional stratified sampling was used to obtain the number of samples from each group of users. Meanwhile, the sample must be representative of the entire population. However, the current population is composed of two groups with different characteristics. Thus, we select the stratum as groups of the population. In addition, a randomly selected sampling technique is used for each group. Finally, the sample size is 379, of which 349 were students and 30 were academic staff [32].

4.1 Research instrument

The data were collected by questionnaire survey. The questionnaire consists of two parts. Part A consists of demographics, such as age, gender, occupation, qualification and general information regarding the Internet, computers and IoT. Meanwhile, part B consists of questions regarding the proposed factors of this study. The scale of five point likert was used with the range (1 for strongly disagree ,2 for disagree, 3 for neutral, 4 for agree , and 5 for strongly agree).

4.2 Questionnaire validity and reliability

Questionnaire validity was confirmed by consulting four experts from Basra University, Mustansiriya University and Tenaga National University. The experts evaluated and adjusted the cohesion and interconnections of the questions. In addition, reliability was examined by conducting a

pilot test on 38 students and academic staff. Cronbach's alphas for the reliability of the pilot test and final collected data were within acceptable thresholds. Table 3 provides the reliability results.

Table 3. Questionnaire reliability

Factor	Items	Reliability values (221)
PE	5	**0.78**
EE	5	**0.79**
SI	6	**0.73**
FCs	5	**0.72**
SEC	5	**0.74**
BI	5	**0.71**
Use behaviour	5	**0.72**

5. Data collection

Student and academic staff received the questionnaires via e-mail. Further, the respondents were given approximately five weeks to fill in the questionnaires. Finally, questionnaire data were collected, and 221 usable sets were entered into SPSS V 22.0.

5.1 Demographics of respondents

Demographic data were obtained from users in Basra University (students and lecturers). In total, 221 respondents were involved to answer the questionnaire items. Most of the respondents were aged 21 to 40 years (126 or 57%).In addition, the respondents were composed of 170 students (76.9%), and of which121 have bachelor degrees (54.8%). The level of computer and Internet knowledge of the respondents was generally positive.

5.2 Hypothesis testing

5.2.1 Correlation analysis. This research used correlation analysis, and correlations between proposed factors should be tested for regression analysis. The purpose for this notion is correlation can pinpoint whether multicollinearity exists or not[33]. Table 4 shows the Pearson correlation coefficient. Between factors, coefficients that are less than 0.90 indicate that multicollinearity is a problem [31].

Table 4. Correlation values

N=221	PE	EE	SI	FCs	SE	C BI	Use behaviour
PE	1	0.50	0.40	0.21	0.30	0.24	**0.25**
EE	0.50	1	0.64	0.48	0.51	0.57	**0.69**
SI	0.40	0.64	1	0.60	0.49	0.65	**0.67**
FCs	0.21	0.48	0.60	1	0.42	0.53	**0.59**
SEC	0.30	0.51	0.49	0.42	1	0.26	**0.52**
BI	0.24	0.57	0.65	0.53	0.26	1	**0.70**
Use behaviour	0.25	0.69	0.67	0.59	0.52	0.70	**1**

5.2.2 Regression analysis. The research hypotheses were tested using regression analysis. Table 5 provides the results, which indicate that the highest predictors of BI are SI followed by EE, SEC and PE. The table also reveals that use behaviour is influenced by FCs and BI. Moreover, the regression coefficient indicates the size effect between independent and dependent factors, which is denoted as (B) or beta. Sig refers to the P-value, which must be less than 0.05 to consider the hypothesis significant. The T statistic is the result of dividing B by the Std. error.

Table 5. Coefficient of regression analysis

M		**Unstandardised coefficients**		**T**	**Sig.**
		B	*Std. error*		
BI	(Constant)	0.55	0.35	1.57	0.16
	PE	0.16	0.07	2.28	0.02
	EE	0.18	0.06	3.03	0.02
	SI	0.21	0.09	2.33	0.00
	SEC	0.17	0.04	4.25	0.00
Use behaviour	(Constant)	−0.25	0.24	−1.05	0.46
	FCs	0.68	0.43	1.73	0.01
	BI	0.35	0.06	5.83	0.02

The results claimed that the influence of BI on use behaviour is significant (B=0.35, P-value<0.05).Therefore, H1 is supported. The effect of PE on BI was affirmed to be significant (B=0.16, P-value <0.05).Therefore, H2 is supported. The UTAUT final factors, which are EE (B=0.18, P-value<0.5), SI (B=0.21, P-value<0.05) and high SEC (B= 0.17, P-value <0.05) were confirmed to be significant. Therefore, H3, H4 and H5 are supported.

In addition, the results of regression analysis illustrates that FCs have a significant influence on the use behaviour of IoT services. The results also contended that FCs significantly affected the use behaviour of IoT services. Thus, H6 is supported.

Table 6 summarises the regression analysis of the proposed model. The table illustrates the value of R-squared in the model, which clarifies the predictive power of the model. It shows that the four factors (PE, EE, SI and SEC) that are linked to BI explain 49.6% of variance in BI towards the use of IoT services, while BI and FCs explain 55.1% of variance in use behaviour.

Table 6. Regression values of the proposed model

Model	*R*	*R-square*	*Adjusted R-square*	*Std. error of estimate*
BI (D.V.)	0.70	0.496	0.487	**1.593**
Use behaviour (D.	0.74	0.551	0.547	**2.232**

Table 7 illustrates the hypothesis testing outline. The beta value pinpoints the size of influence beside the P-value of the relationship. In addition, the research hypotheses were confirmed to be acceptable (P-value less than 0.05).

Table 7. Hypothesis testing outline

Hypotheses	Beta	P-value	Remarks
H1: **BI** positively influence the use behaviour of IoTservices.	0.35	0.02	**Supported**
H2: PE positively influence users' **BI** to use IoT services.	0.16	0.02	**Supported**
H3: EE positively influences users' **BI** to use IoT services.	0.18	0.02	**Supported**
H4: SI has a positive influence on users' **BI** touse IoT services.	0.21	0.00	**Supported**
H5: SEC has a positive influence on **BI** to adopt IoT services.	0.17	0.00	**Supported**
H6: FCs positively influence the use behaviour of IoT services.	0.68	0.01	**Supported**

Figure 2 presents the model of adoption IoT services for higher educational institutions in Iraq. The figure depicts that the four factors of the UTAUT, along SEC, are significant factors for the adoption of IoT services. FCs is the most powerful factor in the model, with a coefficient of 0.68. This result could be recognized due to the lack of internet availability as well as the traditional IT infrastructure in Iraq.

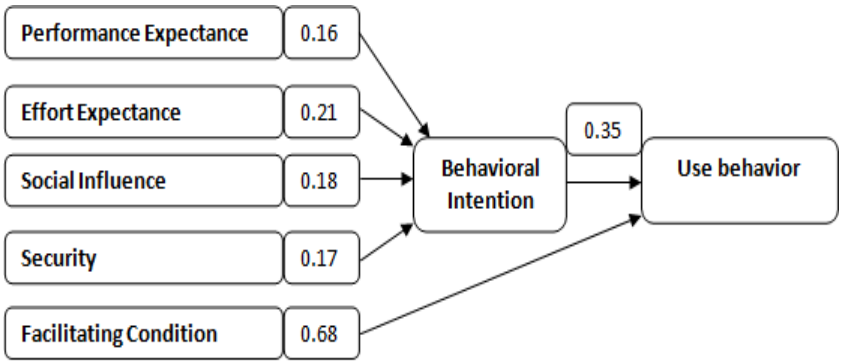

Figure 2. IoT adoption model for higher education institutions in iraq

6. Contribution

This study provided conceptual and realistic contributions. From a conceptual perspective, the model is developed and tested for IoT services in developing countries. In addition, the researches in IoT are in the early stages, and the majority of previous researches are technical. However, this study investigated the adoption of IoT from the behavioural and attitudinal perspectives. In addition, this study added value to the UTAUT model by testing the validity of this model in terms of IoT. Further, the incorporation of SEC was according to the criticism of the UTAUT model. In this regard, this research filled the gap.

In practice, top management and stakeholders can employ the results to improve the use and acceptance of IoT. FCs is the most powerful factor that directly influence use behaviour. The decision makers should establish the proper environment to aid in the evolvement of IoT in educational institutions in Iraq. In addition, awareness about the SI of IoT services, especially for university lecturers and students, should also be increased. Users must be provided with practical courses on the mechanisms of IoT services, and universities must support IoT services and facilitate the accessibility

of internet services for students and lecturers. Ultimately, the Internet should be supplied in universities for all the users in as a consistent technology.

7. Recommendation for future work

The previous researches in IoT services showed that UTAUT model is merely used. In addition, the literature suggested that the concept of IoT services is relatively new. Thus, numerous academic works are required. On the basis of the results, the following recommendations are made.

IoT services are still a new and growing concept. Thus, further studies are required in this field. The literature review validated that the majority of the studies used the TAM as theoretical adoption theory, whereas studies on the UTAUT are few. Therefore, we recommend that future studies deploy the UTAUT because it has the most exploratory power comparing with other models. Researchers can mix between models to derive other pertinent factors that affect the adoption of IoT.

The respondents of the present study were students and academic staff. Future studies should focus on each group of target respondents to delineate issues in relation to the adoption of IoT services. In addition, future studies can incorporate non-academic staff.

The study was conducted on all faculty staff of Basra University. Future work could focus on one or a group of faculties that share certain characteristic. The derived results are linked to individual users, which mean that the organizational aspects need to examine in the future researches. In addition, this research conducted for the higher educational institutions. Therefore, business organisations need to test the proposed model in the future works. In addition, the university could utilise a hybrid cloud to maximize the security level and enhance the adoption of IoT services.

Lastly, on the basis of the R-squared of the BI, the factors that affect BI could explain 49.6% of the variation of BI. We recommend that future studies increase the percentage of variance by incorporating new factors that are related to the country, such as trust, culture and tradition, knowledge of users or university incentive to use IoT services.

8. Conclusion

This research was accomplished in Basra University. The purpose was to discover the factors that influence the adoption of IoT services at higher institutions in Iraq. Moreover, the study reviewed the literature and developed the proposed model. Meanwhile, the UTAUT was employed as a theoretical adoption model. With SEC as an independent factor, UTAUT factors, such as PE, EE, FC, and SI, were deemed to influence use behavior and BI of IoT services.

The respondents were composed of students and lecturers. Data were analyzed by SPSS V 22.0. The results verified that SI has the highest level of influence on the BI to adopt IoT services. This factor was followed by EE, SEC and PE. The FC was more effective than BI as a driver of use behaviour. This result was mainly due to technological infrastructure, which was more important than intention. The pre-requisites for using IoT services are Internet connection, networks and electric supply. Although these pre-requisites are available in Iraq, they require further enhancements.

Authorities and decision makers in higher educational institutions are advised to use IoT services and technology and increase awareness regarding benefits and usability.

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