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Proposed Model of Internet of Things Adoption for Higher Education Institution

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Abstract

In the light of the information technology revolution, the emergence of the Internet of Things (IoT) is an important development that can enhance the efficiency of daily activities, such as increasing communication efficiency for users around the world. Within this context, few users realize the benefits of using IoT services. In general, most of the previous studies focused on technical aspects of the Internet of Things, such as architectural dimensions and wireless sensor networks, and the studies did not focus on examining the perceptions of IoT users. The aim of this study is to determine the factors that affect users' adoption of IoT services in an educational institution in Iraq. Random samples were used to collect data from 302 (faculty) at Northern Technical University. The UTAUT model was used with the addition of two factors (privacy, trust), as current research confirmed the importance of these two factors in the users' decision to adopt new technologies. The current study found that social influence is the most important factor regarding behavioral intention (BI) to use IoT services followed by expected effort, privacy and performance expectations. Facilitating conditions have an impact on the behavior of using IoT services. Finally, the study recommends decision makers in higher education institutions to use Internet of Things services and work to increase users' awareness of its benefits.

Keywords: Internet of things; Adoption factors, Higher Education Institutions; UTAUT, Privacy, Trust.

نموذج مقترح لاعتماد إنترنت الأشياء لمؤسسات التعليم العالي

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المستخلص

في ضوء ثورة تكنولوجيا المعلومات، يعد ظهور إنترنت الأشياء (IoT) تطورًا مهمًا يمكن أن يعزز كفاءة الأنشطة اليومية، مثل زيادة كفاءة الاتصال للمستخدمين حول العالم. في هذا السياق،

يدرك عدد قليل من المستخدمين فوائد استخدام خدمات إنترنت الأشياء، بشكل عام، ركزت معظم الدراسات السابقة على الجوانب الفنية لإنترنت الأشياء، مثل الأبعاد المعمارية وشبكات الاستشعار اللاسلكية، ولم تركز الدراسات على فحص تصورات مستخدمي إنترنت الأشياء. الهدف من هذه الدراسة هو تحديد العوامل التي تؤثر على تبني المستخدمين لخدمات إنترنت الأشياء في مؤسسة تعليمية في العراق. تم استخدام عينات عشوائية لجمع البيانات من 302 (أعضاء هيئة تدريس) في الجامعة التقنية الشمالية. تم استخدام نموذج UTAUT مع إضافة عاملين (الخصوصية والثقة)، حيث أكد البحث الحالي أهمية هذين العاملين في قرار المستخدمين باعتماد تقنيات جديدة. وجدت الدراسة الحالية أن التأثير الاجتماعي هو العامل الأكثر أهمية فيما يتعلق بالنية السلوكية (BI) لاستخدام خدمات إنترنت الأشياء متبوعًا بالجهود المتوقعة والخصوصية وتوقعات الأداء. تؤثر الظروف الميسرة على سلوك استخدام خدمات إنترنت الأشياء. أخيرًا، توصي الدراسة متخذي القرار في مؤسسات التعليم العالي باستخدام خدمات إنترنت الأشياء والعمل على زيادة وعي المستخدمين بفوائدها.

الكلمات المفتاحية: انترنت الاشياء، عوامل التبني، مؤسسات التعليم العالي، UTAUT، الخصوصية، الثقة.

1. Introduction

Technology pioneer ashton introduced in 1999 a definition of the term (IoT), which is an electronic communication network that enables the collection and transmission of information between physical objects (Kanaan et al., 2019: 10). Moreover, she indicated the emergence of a new development in the field of telecommunications, such as the attempt to combine electronic devices such as mobile phones with nanotechnology. Thus, simultaneous integration of electronic devices with other users within the network can be done through (IoT) (Jayashankar et al., 2018: 137). Finally, when organizations and users connect through the Internet, it leads to an intensified growth of the services provided through IoT (Bauer et al., 2014: 2).

Despite the various advantages and services offered by the Internet of Things, such as providing high communication efficiency to users around the world, a limited number of users realize the importance of internet of things services. In addition, there are specific perceptions that people have in their daily lives related to the drive to continue using IoT services. In fact, there are real concerns by many users regarding IoT services such as privacy and trust (Gul et al., 2017:160).

The majority of studies that dealt with the Internet of things focused on technical aspects such as the architectural dimensions of the design of the Internet of Things and the wireless sensor network (Hashim & Al-

Sulami, 2020: 770) and some studies dealt with presenting the concepts of the Internet of things and discussing opportunities, obstacles and challenges (Hsu & Lin, 2016: 518).

Finally, studies have not focused on examining the perceptions of IoT users. The research aimed at discovering the factors affecting the adoption of Internet of Things services in higher institutions in Iraq. The TAM model was used in order to try to assess the perception of Iraqi users about the adoption of the Internet of Things (Gómez et al., 2013: 134). On the contrary, it has been asserted that Technology Use Theory (UTAUT) and Theory (TAM) are influential and have the ability to explain the difference in technology acceptance more than the TAM model (Greenough, 2014:29). They (Venkatesh et al., 2003: 440), (Hashim & Al-Sulami, 2020: 768), also emphasized the difference of the TAM model from the UTAUT model for the study of user adoption of technology. However, despite the explanatory power of the TAM model, the UTAUT model was used due to the lack of confidence and specificity factors. Current research has emphasized the importance of these factors in users' decision to adopt technology (Jayashankar et al., 2018: 137), (Arfi et al., 2021: 164). Developed countries were among the advanced countries in the study of Internet of Things services.

This study examines the extent to which users adopt IoT services in educational institutions in Iraq, which is the right place for IoT. In addition, intense domestic and international investment and economic growth as well as outdated infrastructure have paved the way for a digital revolution. This technology can help the state to increase the efficiency of the educational institution. Thus, this study will be conducted in educational institutions in Iraq to examine the extent to which these institutions are able to apply the internet of things and benefit from its benefits. This study explores the factors affecting the adoption of the internet of things in higher education institutions in Iraq. The study was divided as follows. Neglected areas a review of the literature and its discussions, and clarification of the study model and its hypotheses. Moreover, the third part discusses the research methodology, the results of the study are clarified and discussed in the fourth section. In the end, it presented the conclusions reached by the study and its limitations, in addition to presenting the future directions.

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2. Literature Review

2-1. Internet of things: The formulation of the Internet of Things relies heavily on the concept of integrating and merging sensors with devices, to provide simultaneous communications through the Internet. The Internet of Things requires connectivity to a wide network to achieve communication between devices, machines, and sensing devices. Conceptually, the term Internet of Things has been defined as a process aimed at users interacting with smart devices independently by combining the capabilities of the Internet and intelligence (Aldowah et al., 2017: 893). Technically, the Internet of Things includes three main components, which are infrastructure, devices, and services (Alalade et al., 2019: 50). Thus, the Internet of Things has a large web that is connected to it Physical objects, such as machines and sensors, provide perfect connections between databases and these devices (Njeru et al., 2017: 517). In addition, the Internet of Things provides the user with the ability to control and manage their electrical devices such as security, lighting and heating systems through their mobile devices from anywhere (Ramlowat & Pattanayak, 2019: 14). In the end, the most important difference that distinguishes the IOT from the services that can be obtained through the Internet is that the IOT does not provide services only, but provides the ability to interact with machines and things remotely (Sharma et al., 2019: 30).

2-2. IoT in educational institutions: The rapid technological development in all fields has imposed great challenges on senior management and employees in educational institutions to change the pattern of providing information to students, modernizing educational means and following up on changes that appear in educational environments (Algozani & Aleryani, 2018: 4). In this context, the educational institution, when adopting the Internet of Things, must reconsider its strategies related to learning activities, teaching method, and research mechanisms (Pai, 2017: 22). In addition, the Internet of Things motivates students to interact more and respond, which enhances the state of communication between the teacher and students (Majeed & Ali, 2018: 647). Predicts that the global rate of Internet of Everything (IoE) adoption in education would grow from less than 5% in 2013 to 32% by 2022, owing to customized teaching and data gathering for making better choices (Bagheri & Movahed, 2016: 437). Classify IoT applications in education into four categories: classroom

access control, energy management and real-time ecological monitoring, student health monitoring, and improving teaching and learning (Rico-Bautista et al., 2019: 431).

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) (Yahaya et al., 2018: 4). 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 (Thibaud et al., 2018: 81), (Yahaya et al., 2018: 4). Previous studies described UTAUT as a new theoretical model, reinforcing the shortcomings of previous models (Singh et al., 2017: 837), (Patil, 2016: 407), (Sung & JO, 2018: 97). Most of the previous studies that examined the factors that have an impact on the adoption of the Internet of Things relied on the TAM model or the DOI model (Yuan & Cheah, 2020: 28), (Jaafreh, 2018: 139). While a few studies have used the UTAUT model to discover Factors affecting the adoption of the Internet of Things. In addition, the UTAUT form has been developed to know the individual acceptance of a new technology. The model has been applied in many fields such as medical aspects (Abushakra & Nikbin, 2019: 341) using UTAUT2, investigate and discuss the factors influencing entrepreneurs' acceptance and adoption of the IoT. However, the use of the UTAUT model is still limited in studies dealing with the topic of the Internet of Things. Finally, this study used the UTAUT model with the addition of trust and privacy.

3. **Conceptual model and research hypotheses**:

3-1. Conceptual model: The design of the conceptual model of the study based on the UTAUT model because of its great potential to explore the factors that affect the adoption of technology by the user, and the factors of trust and the privacy factor. Which are among the most important factors that have a major role to ensure the adoption of the internet, have been included. Furthermore, researchers have criticized UTAUT and TAM for excluding trust and privacy factors from their models (Patil, 2016: 406), (Hashim & Hassan, 2015: 341), (Khalilzadeh et al., 2017:467) and (Hashim & Al-Sulami, 2020: 761). Figure 1 show the conceptual model.

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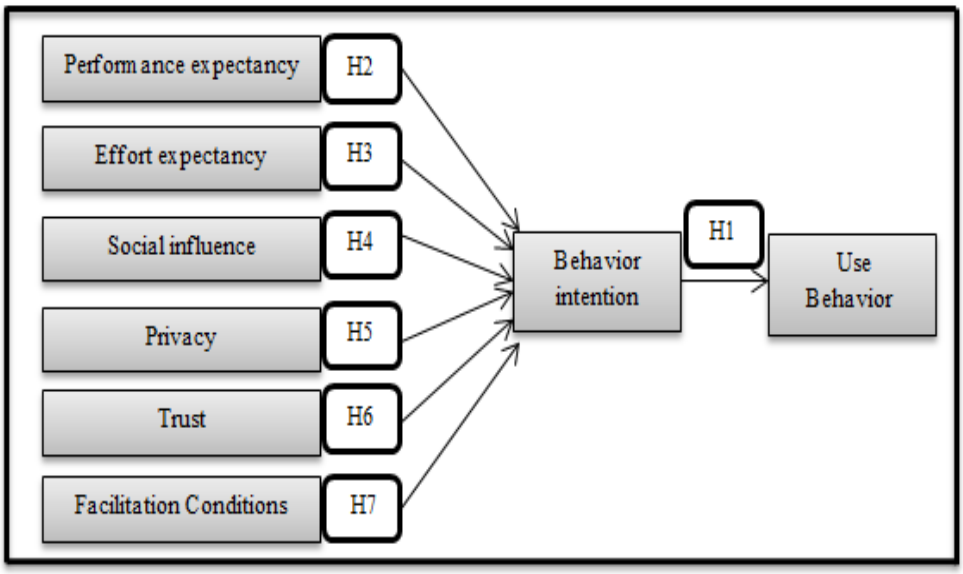

Fig. (1): Conceptual model

3-2. Research hypotheses: Dependent factors in this study are user behavior and behavioral intent. The UTAUT model indicates a direct relationship between use behavior and behavioral intention (Tsourela & Nerantzaki, 2020: 14). This is consistent with the study (Abushakra & Nikbin, 2019: 341), if it confirmed the real use of Internet of Things services, which was strongly affected by the behavioral intention, with regard to this study, behavioral intent is expected to influence IoT usage behavior. Thus, the study assumes the following:

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

In the UTAUT, PE was hypothesized to be a direct predictor of BI (Kim & Lee, 2020:19). According to (Shaikh et al., 2019b:3) and (Romero-Rodríguez et al., 2020:124) is how much an individual believes that utilizing IoT technology will motivate them to improve their job performance. In addition, it represents the users' thought process about how aincreasing gains at work and supporting daily tasks. Experimentally, in the field of IoT users' adoption, studies have proven that PE affects BI (Venkatesh et al., 2003: 440), (Hashim & Al-Sulami, 2020: 768). In this study, it is expected that the users' intention to adopt Internet of Things services will increase if they leave the great advantages offered by this technology. Therefore, the study proposes the following hypothesis.

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

EE refers to the degree of ease with which a system can be used. The simplicity with which technology is used, in particular, has a significant

effect on acceptance behavior (Arfi et al., 2021: 165). The user's intention to adopt new technology is predicted not only by how highly the technology's performance is valued but also by how simple it is to use and how little work is required to operate it (Sinaga, 2019: 4). In addition, studies have demonstrated that the perceived ease of use of the TAM and UTAUT models has a positive effect on the behavioral intention of users when adopting new information technology (Shaikh et al., 2019: 3), (Romero-Rodríguez et al., 2020: 124). Thus, the study assumes the following:

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

In general, any new technology when used, there is a lack of information about it, so users resort to social relationships such as family relationships, colleagues, or friends to get their impressions about this technology [8]. Some researchers in the field of IoT technology have argued that the social impact has a significant impact on user acceptance when adopting internet of thing services (Shaikh et al., 2019: 4), (Hashim & Al-Sulami, 2020: 761). Therefore, in the context of this study it is expected that the user's intention to adopt IoT services will be affected by users who have previously used this technology. Thus, the study assumes the following:

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

Privacy describes the risk user of consumers (Shaikh et al., 2019: 4) about the illegal use and misuse of personal data collected via IoT technology (Kassab et al., 2020: 120). If users sense a risk with their personal data, their chances of adopting an IoT system are slim, regardless of the benefits that it may give, previous study has demonstrated a negative correlation between privacy issues and users' willingness to use an IoT system (Chou & Yutami, 2014: 340). Some researchers in the field of IoT technology have argued that the privacy has a significant impact on user acceptance when adopting internet of thing services (Belanche et al., 2012: 194), (Algozani & Aleryani, 2018: 4). Thus, the study assumes the following:

H5: PR has a positive impact on BI of user to use IoT services.

Trust is a significant variable in the research of online services. Online behavioral studies underline the importance of adding trust in adoption models to better understand user acceptance of such services

(Ennew & Sekhon, 2007: 5). Trust is described as an individual's readiness to accept vulnerability in exchange for favorable expectations about another's intentions or actions in an interdependent and risky scenario (Yahaya et al., 2018: 4). Trust in IoT acceptance and consumer research has developed into a critical element (Shaikh et al., 2019: 3). Following a review of the literature on technology adoption, it was discovered that trust is a significant predictor of behavioral intention (Ajzen, 1991: 180). Trust is one of the most powerful instruments for decreasing uncertainty and risk, and fostering a sense of security has a beneficial effect on behavioral intentions to use IoT devices (Gul et al., 2017: 160). Thus, the study assumes the following:

H6: TR has a positive impact on BI of user to use IoT services.

FC defined as the extent to which an individual feels an organizational and technological infrastructure exists to support the system's use (Venkatesh et al., 2003: 440). FC is described as 'an individual's belief that an organizational and technological infrastructure exists to enable the system's use, FCs have been argued to be an effective predictor of technology acceptance in a variety of contexts, exerting a strong and direct influence on actual technology use (Kim & Lee, 2020: 19), (Ajzen, 1991: 180). FC has effect on the behavior of users of IoT services at an educational institution (Hashim & Al-Sulami, 2020: 761). Thus, the study assumes the following:

H7: FCs has a positive influence on the use behaviour of IoT services.

4. **Research methodology**: The population in this study refers to the faculty at Northern Technical University, which consists of 759 according to the university's website. A sample refers to a group that is selected from the population for representation (Aldowah et al., 2017: 893). The sample for this study was picked randomly, as all respondents have an equal chance of being chosen due to the respondents' homogeneity (Saxl et al., 2021: 50). As a sample, the academic staff was picked (Maddox, 2019: 3). SEM analysis was performed to select a community sample consisting of (100-200) samples statistically, however, through our analysis of past research on my issue, we discovered researchers that employed a community sample of (200-400) individuals (Mathews & Gondkar, 2017: 47), (Yahaya et al., 2018: 4) and (Hashim & Al-Sulami, 2020: 768). As a result, (302) samples were chosen for our investigation.

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, 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. Data collection: Student received the questionnaires via e-mail. Further, the respondents were given approximately four weeks to fill in the questionnaires. Finally, questionnaire data were collected, used structural equation modelling (SEM) to examine the relationships in the UTAUT model and to test hypotheses about the links between the model's variables. (SEM) is a statistical technique that employs a confirmatory (hypothesis testing) approach when analyzing the structure of data reflecting certain occurrences (Sharma et al., 2019: 30). The majority of researchers employ (SEM) as a statistical tool for analyzing data (Tsourela & Nerantzaki, 2020: 14), (Azeez & Lakulu, 2018: 15). Additionally, the data were examined using the software Analysis of Moment Structures (AMOS).

5. Results

5-1. Demographics of respondents: Demographic data was obtained from users at Northern Technical University (students). In total, 221 respondents were engaged to answer the questionnaire items. Most of the respondents were between the ages of 21 and 40 (126 or 57%), in addition to the fact that the respondents consisted of 170 students (76.9%), of whom 121 had a bachelor's degree (54.8%). Level of computer and internet knowledge the respondents were generally positive.

5-2. Structural equation modelling analysis: Structural equation modeling was used to analyze the collected data. A two-step SEM analysis used, the first step is to evaluate the measurement model and the second step is to estimate the structural model. All combinations of the model factor were subjected to the measurement model analyzes and then the structural model analyzes were carried out.

5-3. Measurement model: confirmatory factor analysis: Main fitness indices including CMIN/DF, CFI, AGFI, RMSEA, and GFI were tested to assess model fit. The resulting fitness indices for the standard model for iot were as follows: CMIN/DF 3.264, AGFI = 0.803, GFI = 0.843, CFI = 0.840 and RMSEA= 0.075, As seen in Table 2. Some of these indicators

did not reach the acceptable value (ie, GFI) (Al Mamun & Yuce, 2019: 11), so to enhance the fit of the model re-evaluation and purification were performed. The model optimization process adopted a number of criteria to improve the fit of the model by examining factor loading (standardized regression weights). By inspecting of (factor loading) standardised regression weights, one item (BI4) from behavioural intention,one item (Us1)from use and one item (FC4) from facilitating conditions, and Tow item (TR3, TR5) from Trust and one component of the Effort expectancy (EE1) was less than its terminal value (<0.50) (Algozani & Aleryani, 2018: 4). Hence, the decision was to remove these four items. The CFA test was performed a second time without the extra elements, and the model's fitness improved significantly.

5-4. Hypothesis testing: The statistical results obtained for the fit indicators of the structural model indicate that the structural model is adequately fitted to the data. In the path factor analysis, the causal pathways suggested in the conceptual model supported to be significant. Accurately, behavioral intention was found to be predicted by UTAUT2 factors, PE (CR = 5.281, P < 0.00), SI (CR = 5.770, P < 0.00), PV (CR = 3.469, p < 0.01), and TR (CR = 6.854, p < 0.01). However, the results did not support the performance expectation pathway with behavioral intention (CR = 0.466, p < 0.64), and the FC pathway with behavioral intention was not a significant path t (CR = 2.134, p < 0.03). Since some factors have a positive effect on the behavioral intention to adopt IoT, and therefore, the three main hypotheses are accepted (H1, H2, H4, H5, and H6). while two hypotheses: H3 and H7 were rejected.

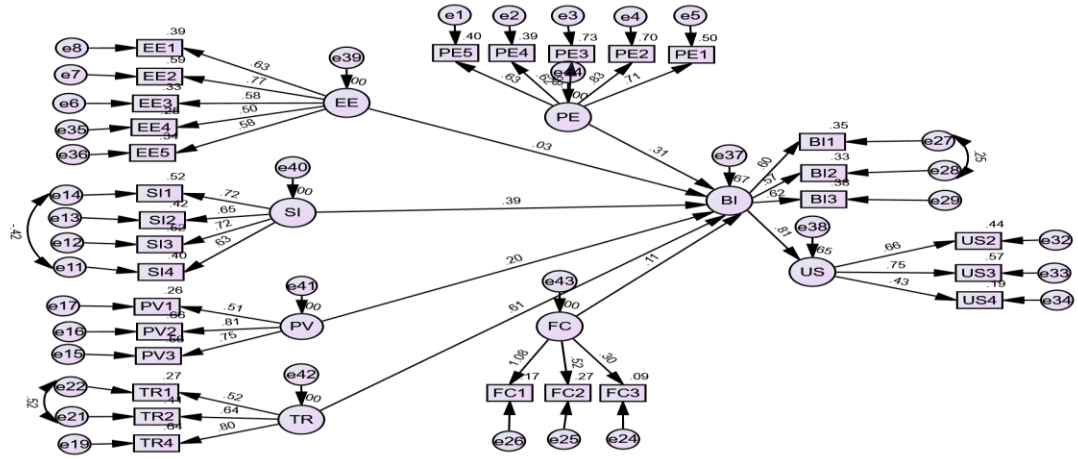

Fig. (2): Structural model

6. **Discussion:** Statistical results proved that able to internal structures of the model to reach an acceptable level of predictive power. In addition, the criteria related to the measurement model all achieved success in the validity and suitability of the model and the reliability of the construction. And in the UTAUT2 model the trust factor and privacy factor are included. In the path analysis, it was found that the trust factor coefficient value of TR (CR = 6.854, $p < 0.01$) proved to be an important factor for predicting perspective of academic staff when adopting iot.This result is in agreement with the study (Yadav et al., 2016: 5), (Gao & Bai, 2014: 4). The results confirmed the role of Pv in behavioral intention, this indicates that privacy has an important role when faculty members adopt the Internet of Things. These results are in agreement with what has been validated by IS field studies and IOT studies associated with the role of privacy (Kassab et al., 2020: 120), (Algozani & Aleryani, 2018: 4). The results confirmed the role of social influence in behavioral intention, which indicates the possibility of the influence of relatives and friends on mobile phone users' intention when adopting the IOT. These results are in agreement with what has been validated by IS field studies and IOT studies associated with the role of social influence (Shaikh et al., 2019: 3), (Hashim & Al-Sulami, 2020: 761).Statistical results (FC= 5.074, $p < 0.00$) confirmed the existence of an effect of facilitating conditions on the adoption of IOT. This indicates respondents' interest in having the skills and resources required to ensure the successful use of IOT. This result is consistent with the results of studies that dealt with facilitating conditions (Kim & Lee, 2020: 20), (Ajzen, 1991: 181). Statistical results showed strong evidence the path weight of the path between behavioral intent and effort expectancy 7.662, which confirms this path. This result indicates that the aspects related to performance expectation are among the academic staff ' attention that affect their intention to adopt and use IOT. Results showed that the relationship is not significant with a regression weight of 0.341 between behavioral intention and effort expectancy when adopting the IOT. This result clearly shows that academic staff are concerned about use of IOT. This could be due to academic staff concern that they need to have special skills to deal with IOT services (Gul et al., 2017:160).
7. **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, studies in the IoT are still in their early stages, and most of the previous studies have focused on technical aspects. However, this study examined the adoption of the Internet of Things from a behavioral and behavioral perspective. Moreover, this paper fills the gap related to adding TR to the UTAUT model, which was one of the most important criticisms leveled against this model. In practice, the results of this study can be used by stakeholders or senior management in educational institutions to improve the use and acceptance of the IoT. FCs are the strongest and most important factors that have a direct impact on usage behavior. Therefore, decision makers in educational institutions in Iraq must create the appropriate environment to help develop the IoT. In addition, work to raise awareness about SI for IoT services, especially for students and teachers. Finally, educational institutions should facilitate access to and support IoT services.

8. **Recommendation:** For future directions, previous studies related to IoT services showed the use of the UTAUT model only. In addition, the concept of IoT services is a relatively new term. Hence, more academic studies are needed. After reviewing the literature, it was found that most studies used the TAM model of adoption, while the UTAUT model is still little used in studies. Therefore, the study recommends that UTAUT be published because it has more exploratory power compared to other models. Researchers can combine models used to measure adoption to explore more factors that have an impact on IoT adoption. The participants in the current study were academic professors. Therefore, future studies should focus on non-academic personnel. In addition, this study was conducted for institutions of higher education. Therefore, the proposed model for business organizations can be tested in future studies.
9. **Conclusion:** This study was completed at the Northern Technical University. The aim was to discover the factors that influence the adoption of IoT services in top institutions in Iraq. Moreover, the UTAUT model was used as a theoretical basis for measuring adoption. With the trust and privacy as an independent factor, UTAUT factors, such as PE, EE, FC, and SI, were considered to influence the usage behavior and BI of IoT services. The respondents consist of professors. Data analysis using SPSS V 22.0. and AMOS The results confirmed that SI has the highest level of impact on business intelligence for the adoption of IoT services. This factor was

followed by EE, SEC, and PE. FC was more effective than business intelligence as a driver of usage behaviour. This result was mainly due to the technological infrastructure, which was more important than the intent. Prerequisites for using IoT services are Internet connectivity, networks and electricity supply. Although these prerequisites are available in Iraq, they require further improvements. Authorities and decision makers in higher education institutions are advised to use IoT services and technologies and to raise awareness about the benefits and ease of use.

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