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Un análisis del Modelo de Aceptación de la Tecnología TAM para comprender la intención del comportamiento de la facultad en el uso del Internet de las Cosas IOT

An analysis of the Technology Acceptance Model TAM in understanding Faculty's behavioral intention to use Internet of Things IOT

Abdulaziz Alzahrani.
University of Ha'il Saudi Arabia.
alzahrani.aziz@gmail.com

RESUMEN.
El estudio se enfoca en examinar la autosuficiencia de los miembros de la facultad en dos departamentos -Tecnología de la Instrucción y Ciencias de la Computación- en el uso del Internet de las Cosas (IoT) en las universidades saudíes. Para lograr el objetivo del estudio, se utilizó el Modelo de Aceptación de la Tecnología (TAM) para probar el efecto de la autosuficiencia en el uso del IoT en la educación. El TAM incluye las siguientes variables: Autosuficiencia de los miembros de la facultad (FMSE), Utilidad percibida (PU), Facilidad de uso percibida (PEOU), Actitud (AT), e Intención del comportamiento para utilizar el IoT (BI). El estudio consiste en una investigación cuantitativa, y el instrumento utilizado fue una encuesta desarrollada para medir la autosuficiencia de los miembros de la facultad. Los resultados mostraron que los miembros de la facultad que tienen más confianza en sus habilidades tecnológicas son más propensos a ver la tecnología IoT como algo beneficioso. La facilidad de uso percibida afectó tanto a la utilidad percibida como a la actitud hacia la adaptación de la IO. Sin embargo, la utilidad percibida no afectó a la actitud, y la actitud no influye en la intención de comportamiento para adoptar la tecnología IoT.

PALABRAS CLAVE.
Modelo TAM, Autosuficiencia, Uso del Internet de las Cosas.

ABSTRACT.
The study focuses on examining faculty members' self-efficacy in two departments – Instructional Technology and Computer Science – in using the Internet of Things (IoT) in Saudi universities. To achieve the study's goal, the Technology Acceptance Model (TAM) was used to test the effect of self-efficacy in the use of the IoT in education. TAM includes the following variables: Faculty Members' Self-efficacy (FMSE), Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude (AT), and Behavioral Intention to Use IoT (BI). The study consists of quantitative research, and the instrument used was a survey developed to measure faculty members' self-efficacy. The results showed that faculty members who have more confidence in their technology skills are more likely to view IoT technology as beneficial. Perceived ease of use affected both perceived usefulness and attitude toward adopting the IoT. However, perceived usefulness failed to affect attitude, and attitude does not influence behavioral intention to adopt IoT technology.

KEY WORDS.
TAM Model, Self-efficacy, Using the Internet of Things.

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1. Introduction.

Technology is becoming increasingly crucial for humans and has significantly altered the way and the type of work done by individuals. It is a tool that aids in information delivery and knowledge transfer among people. The adoption of technology, which can be explained by the process of choosing and using technology by an individual or organization, is a complex topic that is affected by multiple factors (Ja afreh, 2018). In the 21st century, particularly in the field of education, many innovative technologies have evolved and been employed to support the e-learning process (Patil, 2016). This interest has increased significantly since the emergence and spread of Covid-19 and the drastic changes that have consequently occurred (Mhmoud et al., 2021). In today's technologically advanced world, e-learning is one form of technology-mediated learning that utilizes technology in order to facilitate the learning process (NuriAbdalla, 2019). Virtual classrooms and remote communication are becoming more common, and they can be an efficient alternative to traditional classrooms (Mhmoud et al., 2021). These classes utilize a variety of tools such as video broadcasting, voice interaction, text messages, and a whiteboard, and this promotes direct interaction between students and teachers. In addition, faculty members are now able to benefit from the IoT through the use of numerous methods and tools that facilitate their work and enhance educational outcomes (Mhmoud et al., 2021). IoT technology is relevant to the educational process through communication, linking instructional information, and facilitating engagement between faculty and students in the educational process through communication, connecting instructional information, and offering an integrated environment (Mhmoud et al., 2021). As the educational process becomes more modernized, systems are moving toward finding practical and intelligent solutions and employing technologies as well as taking advantage of the Internet of Things (IoT) (Mhmoud, Nafie and Musa, 2021). In Saudi Arabia, the teaching staff in some universities has successfully used the Internet of Things to send notifications about smart systems, make decisions, and save energy (Alaloni, 2021). In addition, the use of the internet and modern technology platforms – as well as the innovation of new technologies such as artificial intelligence (AI), machine learning, and other intelligent digital technologies – has supported schools and universities in sustaining their goals of achieving quality and efficiency in learning (Patil, 2016). Mhmoud, Nafie, and Musa (2021) added that technological advances via innovations such as 5G networks, the Internet of Things, electronic platforms, and virtual classrooms have also contributed to the reduction of certain barriers to education. For example, students are now able to get enrolled in different distance learning programs and attend any university around the world without the need to be physically present (NuriAbdalla, 2019).

Consumer use of IoT devices and new innovative wearable technologies is projected to accelerate (Patil, 2016). As connected devices proliferate and lower-cost platforms and standards are developed, IoT-enabled capabilities will rapidly grow across retail industries (Patil, 2016). These two facts explain the importance of working on improving technology acceptance by providing proper education to organizations and conducting in-depth studies that understand consumer behavior.

Internet of Things in Education.

IoT stands for the Internet of Things, which connects the physical world to cyberspace via smart devices (Al-Abdullatif et al., 2022). The term was coined by Ashton in 1999, and since then, IoT has redefined people's interaction with and perception of technology (Tsourela & Nerantzaki, 2020). The rapid technological advancement of the Internet of Things (IoT) over the last few years has been noticed across the globe (Jaafreh, 2018). IoT can be defined as an infrastructure that plays a role in supporting the telecommunication and connection of different objects, both physical and virtual, via the specified protocols and technologies of an information society (Al-Abdullatif et al., 2022). A

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simpler definition of the Internet of Things is a system of objects, smart devices, and multiple sensor systems that are directly connected to the Internet, allowing them to send data and information and be interacted with by humans (Alaloni, 2021). The linked objects can be anything, such as a person or physical equipment capable of transferring data across a network (Jaafreh, 2018). Elijah et al. (2018) described the IoT system as consisting of many components, which can be IoT devices, communication technology, and the Internet as well as data storage and processing units.
IoT systems have become ubiquitous in recent years, and their widespread acceptance has changed countless aspects of life for millions of people. Many businesses are increasing their investments in IoT systems, regardless of the complexity of their application (Jaafreh, 2018). With the adoption of the IoT, businesses can develop new ways of connecting and creating value as a result of digital transformation in industry (Jaafreh, 2018). A wide range of IoT applications exists, including those in automotive, telecommunications, energy, and many other fields. Moreover, many systems, such as the educational system, were involved with IoT. For example, there has been a move toward smart schools and smart university campuses with the Internet of Things as a foundation; it leads to the complete integration of teaching, educational administration, and campus life through the use of information technology to develop smart services and management (Alaloni, 2021).
Regardless of all the advantages offered by the integration of IoT, there are several challenges that must be taken into consideration in order to maximize its potential and minimize future problems. For example, IoT installations face many challenges, including managing increasing volumes of data, sensor security, data privacy, and government regulations and laws (Patil, 2016). Moreover, Tsourela and Nerantzaki (2020) have cited security and privacy issues as significant challenges for user-oriented IoT applications. Jaffar (2019) reports that, in general, there are a few studies that have discussed the adoption of IoT in order to better understand how users perceive new IT technologies. To be aware of the challenges, it is necessary to conduct research focusing on IoT acceptance models and IoT technology acceptance from the customer point of view (Tsourela & Nerantzaki, 2020). Jaffar (2019) added that pointing out behavioral, organizational, and business issues is also essential. Eventually, the information provided from these studies will be helpful in the development of strategies for management and other stakeholders interested in effectively implementing IoT.

Acceptance of new technology use in education.
The acceptance of the Internet of Things is based on a variety of technological-psychological perspectives, with its affective, cognitive, behavioral, and technological components involved in the process (Tsourela & Nerantzaki, 2020). A study by Isaac et al. (2017) investigated the acceptance of new technology use in Yemen by measuring different variables that affect internet usage and examining its impact on employee performance within government institutions. The study reported that perceptions of ease of use and perceived usefulness have positively and strongly affected technology acceptance and use, and increased adoption has positively influenced performance (Isaac et al., 2017). Another study by Al-Abdullatif, Al-Dokhny and Drwish (2022) reported consistent findings when it comes to the positive effect that perceived usefulness and ease of use have on accepting and using technology. According to Jaafreh (2018), culture is related to the values and beliefs of an individual and is a well-known variable that affects human behavior, decisions, and acceptance of certain concepts; thus, it is a strong predictor of consumer technology acceptance.
This is backed up by the fact that IoT usage and acceptance were lower in Saudi educational systems and less research was conducted on this issue (Al-Abdullatif et al., 2022). NuriAbdalla (2019) notes that various factors, such as proper system design, user-friendliness, and end-user involvement can influence student satisfaction and acceptance of technology. NuriAbdalla (2019) further explained that using technology appropriately not only helps students accept the system and

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learn, but also increases desirable learning outcomes for them. Moreover, Mhmoud, Nafie, and Musa (2021) found that consumers are less likely to accept a system if access to the internet and technology is difficult. According to them, lower acceptance is reported among students who were unable to reach and use the internet and its technologies (Mhmoud et al., 2021). It was also noted that there is a difference in acceptance between university students of different majors; students from the College of Information Technology showed higher acceptance and awareness of technology compared to students from other majors (Mhmoud et al., 2021). Other variables influencing user acceptance and adoption of IoT technologies include technological challenges, human characteristics, environmental constraints, and pricing (Tsourela & Nerantzaki, 2020).
Another important factor that must be considered is age. Kim, Lee, and Shin (2017) noted that the new technology acceptance rate can vary among different age groups, where younger age groups tend to be more accepting than older age groups. In order for e-learning to have a significant influence on the education system, the transition between traditional patterns and new ones must be preceded by a realignment of the triple education diagram, which involves the student, faculty member, and educational organization (Mhmoud et al., 2021). Further studies, specifically qualitative studies, are required to gain an in-depth understanding of consumer behavior.

Purpose of study.
This study focuses on examining the effect of faculty members' self-efficacy toward the use of IoT in two departments – Instructional Technology and Computer Science – in Saudi universities. It identifies faculty members' perspectives toward IoT in the educational system. This gives evaluation views of instructors' technological abilities and acceptance of using IoT as a new technology in education. This study also examines the effects of TAM model variables in the context of IoT. TAM model categories are very consistent with the goal of this study, which explores intentions of using IoT in universities. Therefore, the study proposes a detailed examination into adopting IoT in Saudi universities in the future.

2. Literature Review and Theoretical Framework.

Technology Acceptance Model (TAM).
Many models have been used by prior research papers to test acceptance and technology use. However, it may not be possible to apply all of the leading technology acceptance theories to analyze consumers' adoption of IoT applications (Tsourela and Nerantzaki, 2020). An individual's acceptance of information systems is best described through the Technology Acceptance Model (TAM), which has been supported by many prior studies (Isaac et al., 2017; Jaafreh, 2018). In comparison to other models, the TAM model was more powerful and more capable of explaining variances in technology adoption (Jaafreh, 2018). The model was developed in response to a modification of the Theory of Reasoned Action (TRA) in order to explain the determinants of user acceptability of new information systems (Jaafreh, 2018).

TAM's Core Variables.
This model, developed by Davis in 1989 (Patil, 2016), focuses on two main constructs – namely, ease of use and usefulness – with the intent to utilize acting as a mediator of real system usage (Jaafreh, 2018). Working on the perceived usefulness (PU) of IoT technologies, which was identified as a measure to determine people's intentions, can be achieved by proper communication of the benefits to consumers (Tsourela & Nerantzaki, 2020). On the other hand, perceived ease of use (PEOU) can be achieved by ensuring that consumers are aware of and confident in using the adopted system (Jaafreh, 2018; Kim et al., 2017). It is also essential to note that individuals perceive

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technological products and systems as being more useful if they consider the use of those products/systems simple and easy (Tsourela & Nerantzaki, 2020). This shows the interrelation between the two TAM components and that the perceived ease of use can predict perceived usefulness. Tsourela and Nerantzaki (2020) explained that behavioral intention (BI) also plays a significant role in predicting acceptance, where individuals with higher BI are more likely to adopt technology when compared to those with lower BI. This factor was influenced by both perceived usefulness and perceived ease of use. In addition, Kim, Lee, and Shin (2017) noted the importance of prioritizing self-efficacy as a critical variable that predicts acceptance and must be utilized with the TAM model.

When it comes to the benefits, Rad et al., (2022) explained that the TAM model can predict teachers' sense of technology acceptance and provide educational decision-makers with timely intervention ideas that can enhance success rates. Another study by Kim, Lee, and Shin (2017) showed that the use of the TAM model, including PU and PEOU constructs, assisted in measuring the acceptance of consumers to the use of smart technologies.

Teachers' self-efficacy toward IoT.

When it comes to the acceptance and use of IoT, it's important to consider not just the students' viewpoint but also the teachers'. According to Huda and Yulisman (2020), there is a lack of studies on the acceptance rate among teachers in some countries like Indonesia. In Kuwait, the teachers reported the internet as the backbone of the educational process and an essential part of the university education system; however, many challenges on a personal and organizational level act as barriers to its implementation (Mhmoud et al., 2021). Huda and Yulisman (2020) further supported this fact and added that the use of technology among teachers is influenced by multiple internal and external factors. At a personal and internal level, self-efficacy is the concept of an individual's assessment of their own ability to perform specific actions or tasks (Kim et al., 2017). In regards to the internet, Internet self-efficacy (ISE) is defined as the ability to confidently use the Internet and its technologies (Isaac et al., 2017). Prior papers reported higher self-efficacy levels associated with higher levels of technology adoption and acceptance (Huda & Yulisman (2020); Isaac et al. (2017); Kim, Lee, and Shin, (2017)). In terms of perceived ease of use and perceived usefulness, self-efficacy plays a significant role and was found to be a significant predictor (Isaac et al., 2017). Despite this, Isaac et al. (2017) noted that perceived ease of use is more strongly associated with internet self-efficacy than perceived usefulness. In another study, pre-service teachers' perception of the usefulness of the IoT was the most important factor that influenced whether or not they would use it in the future (Al-Abdullatif et al., 2022).

In their study of teachers' self-efficacy, Huda and Yulisman (2020) find that the availability of internet infrastructure has a significant bearing on teachers' self-efficacy and intention of using the internet. They also argued the importance for policymakers and organizations to have strong internet connections and information and communication technology infrastructures in all education facilities (Huda & Yulisman, 2020). Mhmoud, Nafie, and Musa (2021) reasoned that there is also a need to train teachers to be confident while using the new technology. Self-efficacy can be further improved by focusing on the teachers' technical skills and proper teacher preparation programs (Al-Abdullatif et al., 2022). This was supported by teachers from Sudan, who conveyed the need to encourage and educate faculty members in Sudanese universities to benefit from the technology of virtual classrooms (Mhmoud et al., 2021). Ultimately, having properly trained teachers will enable them to interact and use technology more effectively, thus gaining the most benefit from it.

To conclude, the understanding of teachers' self-efficacy in relation to IoT will advance as more research is conducted into the critical factors influencing their motivation to utilize IoT and, therefore, their actual performance in using IoT. In their remarks, Al-Abdullatif, Al-Dokhny, and Drwish (2022)

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recommended incorporating IoT technologies into teacher training programs and evaluating the impact they may have on classroom design and practice in order to have a proper self-efficacy measurement among teachers. Therefore, this study proposes the following hypotheses:
H1: FMSF has a positive effect on PU of Instructional technologies.
H2: FMSF has a positive effect on PEU of Instructional technologies.
H3: PEU has a positive effect on PU of Instructional technologies.
H4: PU has a positive effect on AT of Instructional technologies.
H5: PEU has a positive effect on AT of Instructional technologies.
H6: AT has a positive effect on BI of Instructional technologies.
H7: PU has a positive effect on BI of Instructional technologies.
H8: PUE has a positive effect on BI of Instructional technologies.

Table 1.
Research hypotheses

Hypotheses	Connection	Description
H1	SE+PU	Faculty members' self-efficacy will positively affect perceived usefulness related to IoT
H2	SE+PEOU	Faculty members' self-efficacy will positively affect the ease of use related to IoT
H3	PEOU+PU	PEOU will positively affect PU in the context of IoT
H4	PU+AT	Perceived usefulness is positively affected by faculty members' attitudes toward IoT
H5	PEOU+AT	Perceived ease of use is positively affected by faculty members' attitudes toward IoT
H6	AT+BI	Faculty members' attitudes toward IoT will positively affect their behavioral intention to use IoT
H7	PU+BI	Perceived usefulness will positively affect faculty members' behavioral intention to use IoT
H8	PEOU+BI	Perceived ease of use will positively affect faculty members' behavioral intention to use IoT

Table 1 shows the relationship between the eight hypotheses considering self-efficacy (SE), perceived usefulness (PU), perceived ease of use (PEOU), attitude (AT), and behavioral intention (BI). The variables' connections shown in Table 1 is a strong proof demonstrating that the TAM model is an effective model to examine the use of new technologies.

3. Methodology.

The quantitative research design applied to achieve the goal of this study. In this study out of 140 questionnaires distributed, 131 responses were received. From those 131 responses, 129 responses were found valid and completed. Therefore, these 129 complete and usable responses were used in the quantitative data analysis. The study response rate is considered a very good response rate, as it scored a total response rate of (93.57%). Two surveys were adopted from Isaac et al. (2017); Tsourela and Nerantzaki (2020) to achieve the purpose of study.

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4. Resutls.

Demographic Information.

Demographic information showed that 51.9% (67) of the respondents were taken from the instructional technology department, while 48.1% (62) were taken from the computer science department. Furthermore, the study showed that 57.4% (74) of the respondents were male and 42.6% (55) of the respondents were female. 23.3% (30) of the respondents have 1-5 years of experience, 37.2% (48) of the respondents have 6-10 years of experience, 20.2% (26) of the respondents have 11-15 years of experience, and 19.4% (25) of the respondents have more than 15 years of experience, as shown in Table 2.

Table 2.
Demographic information (N=129)

		N	%	Valid %	Cumulative %
Department	Instructional Technology	67	51.9	51.9	51.9
	Computer Science	62	48.1	48.1	100
	Total	129	100	100	
Gender	Male	74	57.4	57.4	57.4
	Female	55	42.6	42.6	100
	Total	129	100	100	
Years of experience	1 to 5 years	30	23.3	23.3	23.3
	6 to 10 years	48	37.2	37.2	60.5
	11 to 15 years	26	20.2	20.2	80.6
	More than 15 years	25	19.4	19.4	100
	Total	129	100	100	

Normality test.

The skewness measure can be used to determine both the direction and size of the lack of symmetry, while the kurtosis measure can be used to determine whether or not the distribution is flat. A normal probability plot can be said to have skewness when symmetry is absent (Hair et al., 2021). The study also utilized a normality test to evaluate the threshold values for skewness and kurtosis. The study also ensures the normality distribution of the data. The values were between -2 and +2 for skewness and -7 and +7 for kurtosis (Bryne et al., 2010). Finally, the study proved that the data was based on normal distribution.

Assessment of Model.

Assessment of validity and reliability.

The validity of the variables in this research was evaluated using convergent and discriminant criteria. Convergent validity is defined as the average variance extracted (AVE) value and the loading of the items. When a new item is being tested, it's important that every item's factor loading be more than 0.7 (Mashal & Shuhaiber, 2018). When dealing with established latent items, the factor

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loading for each item needs to be at least 0.7 (Rouf & Akhtaruddin, 2018). Wang et al. (2021) said that an acceptable AVE value is 0.50 and higher. The AVE value in this investigation has met the standards (Table 2). The attainment of convergent validity in this research was also proved in the findings of cross-loadings. Hair et al. (2021) said that the convergent validity condition for outer loading must be over 0.70 (Hair et al., 2021; Mashal & Shuhaiber, 2018), and the p-value is significant (<0.05). Table 2 reveals that the loadings were higher than 0.70 and the AVE value for each latent construct was also higher than 0.5, so there was good convergent validity.
Composite reliability and Cronbach's alpha were used to evaluate the dependability of the instruments in this study. Table 3 displays composite reliability and a Cronbach's alpha value greater than 0.70, which meets the strict threshold for composite reliability and Cronbach alpha set by the study authors (Hair et al., 2021; Mashal & Shuhaiber, 2018). Based on these threshold values, the study ensured the validity and reliability of the variables.

Table 3.
Validity and reliability of the constructs

Constructs	Items Code	Factor Loadings	AVE	Cronbach alpha (α)	Composite reliability
Attitude	AT1	0.769	0.627	0.708	0.834
	AT2	0.803			
	AT3	0.802			
Behavioral Intention to use IoT	BI1	0.766	0.629	0.852	0.894
	BI2	0.778			
	BI3	0.823			
	BI4	0.799			
	BI5	0.798			
Faculty Members' Self-efficacy	FMSF1	0.748	0.559	0.843	0.883
	FMSF2	0.799			
	FMSF3	0.722			
	FMSF4	0.721			
	FMSF5	0.708			
	FMSF6	0.782			
Perceived ease of use	PEOU1	0.896	0.658	0.869	0.905
	PEOU2	0.899			
	PEOU3	0.905			
Perceived usefulness	PU1	0.826	0.810	0.884	0.928
	PU2	0.701			
	PU3	0.843			
	PU4	0.847			
	PU5	0.830			

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Cross-loadings occur when a variable is determined to have multiple significant loadings (the number depends on the sample size), making it difficult to distinguish between factors that share a variable (Hair et al., 2021). Cross-loadings suggest that an item's loadings on its latent construct must be greater than those on any other constructs in the research (Wang et al., 2021). The item's discriminant validity is questioned if it loads more strongly on a different construct than on its parent construct. Finally, the study proves good cross-loadings according to the threshold criteria, as shown in Table 4.

Table 4.
Cross-loadings

	Attitude	Behavioral Intention to use IoT	Faculty Members' Self-efficacy	Perceived Usefulness	Perceived ease of use
AT1	0.769	0.265	0.377	0.150	0.391
AT2	0.803	0.398	0.366	0.280	0.362
AT3	0.802	0.411	0.366	0.431	0.446
BI1	0.300	0.766	0.494	0.506	0.418
BI2	0.338	0.778	0.541	0.564	0.375
BI3	0.327	0.823	0.425	0.455	0.457
BI4	0.464	0.799	0.565	0.432	0.478
BI5	0.400	0.798	0.402	0.474	0.484
FMSF1	0.423	0.514	0.748	0.507	0.351
FMSF2	0.427	0.559	0.799	0.572	0.343
FMSF3	0.363	0.443	0.722	0.323	0.320
FMSF4	0.255	0.339	0.721	0.434	0.230
FMSF5	0.345	0.430	0.708	0.397	0.252
FMSF6	0.260	0.433	0.782	0.552	0.287
PEOU1	0.389	0.475	0.313	0.378	0.896
PEOU2	0.437	0.480	0.326	0.362	0.899
PEOU3	0.527	0.543	0.427	0.489	0.905
PU1	0.330	0.570	0.520	0.826	0.477
PU2	0.227	0.418	0.433	0.700	0.317
PU3	0.397	0.531	0.591	0.843	0.425
PU4	0.242	0.469	0.530	0.847	0.296
PU5	0.333	0.481	0.486	0.830	0.329

The Heterotrait-Monotrait Ratio (HTMT) offers proof of the discriminant validity of the test (Wang et al., 2021). Henseler, Ringle, and Sarstedt (2015) presented a novel method for evaluating the validity of the discriminant analysis. This method is known as the HTMT. A measurement of the degree to which two latent variables are the same is provided by the HTMT. This study utilizes the HTMT of correlation coefficients (HTMT) to assess discriminant validity in variance-based SEM. Instead, the Fornell–Larcker criterion and assessment of the cross-loadings are not used to measure discriminant validity, as cross-loadings and Fornell-Larcker criteria are not appropriate in variance-based SEM (Henseler, Ringle, and Sarstedt (2015)). In conclusion, all variables have achieved discriminant

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ISSN: 2386-4303 DOI https://doi.org/10.46661/ijeri.7461

validity because their values were lower than 0.90, as demonstrated by the ratio of HTMT. Finally, the study ensures discriminant validity in terms of cross-loadings and HTMT ratio, as shown in Table 5.

Table 5.
HTMT Ratio

	Attitude	Behavioral Intention to use IoT	Faculty Members' Self-efficacy	Perceived Usefulness	Perceived ease of use
Attitude					
Behavioral Intention to use IoT	0.579				
Faculty Members' Self-efficacy	0.598	0.713			
Perceived Usefulness	0.453	0.707	0.720		
Perceived ease of use	0.628	0.638	0.452	0.512	

Multicollinearity (VIF)

Additionally, to identify the problem of CMV, the study implemented a statistical method that involved a thorough collinearity test in units of variance inflation factor (VIF). All VIF readings were within the allowable range of 3 or lower, which is the threshold that Hair et al. (2021) suggest. To determine whether or not multicollinearity is present, VIF is applied. The fact that the maximum value for VIF was found to be 2.906 suggests that there was no multicollinearity issue in this investigation. Because the VIF values fell within the permissible range of 3.0 or less (Henseler, Ringle, and Sarstedt, 2015), the collinearity problem could not be identified in the data, as shown in Table 6.

Table 6.
VIF values

	Attitude	Behavioral Intention to use IoT	Faculty Members' Self-efficacy	Perceived Usefulness	Perceived ease of use
Attitude		1.401			
Behavioral Intention to use IoT					
Faculty Members' Self-efficacy				1.191	1.000
Perceived Usefulness	1.271	1.321			
Perceived ease of use	1.271	1.518		1.191	

Fecha de recepción: 16-09-2022 Fecha de aceptación: 28-09-2022
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Assessment of path model.

A path model illustrates the causal connections between various qualities of variables. In path analysis, the exogenous variables affect outcome variables on the right being predicted by the variables on the left. The study used a bootstrapping technique to test the proposed research hypotheses (Hair et al., 2021; Wang et al., 2021). Bootstrapping is a statistical approach that enables testing of the statistical significance of a variety of PLS-SEM outcomes, including path coefficients and R^2 values, among others (Henseler, Ringle & Sarstedt, 2015). As it analyzes linear causal links across variables while concurrently taking measurement error into account, this method is comparable to regression analysis but possesses greater power. The study employs beta, t-value, and p-value to test the proposed research hypotheses. The study applied to bootstrap with 500 sub-samples to ensure beta values, t-values>+1.96 (Hair et al., 2021; Rouf & Akhtaruddin, 2018), and p-value<0.05, with a confidence interval of 95% (Mashal & Shuhaiber, 2018; Wang et al., 2021). P-values are the standard method that researchers use when testing hypotheses in PLS-SEM, where each hypothesis relates to a different path in a model. One-tailed or two-tailed P values can be calculated depending on prior knowledge regarding the orientation of the path and the value of the coefficients linked with it (Hair et al., 2021).

Finally, the study reported that faculty member self-efficacy significantly and positively influenced perceived usefulness (beta=0.537***, *t*-value=7.504, *p*-value=0.000), so hypothesis 1 was supported. Meanwhile, faculty member self-efficacy also significantly and positively influenced perceived ease of use (beta=0.401***, *t*-value=5.201, *p*-value=0.000), so hypothesis 2 was supported. It is concluded that faculty members have higher perceptions of engaging in perceived usefulness than perceived ease of use. Perceived ease of use significantly and positively influenced perceived usefulness (beta=0.247**, *t*-value=2.984, *p*-value=0.003), so hypothesis 3 was supported. Perceived usefulness did not significantly influence attitude toward adopting IoT technology (beta=$0.190^{n.s}$, *t*-value=1.664, *p*-value=0.096), so hypothesis 4 was not supported. Perceived ease of use significantly and positively influenced attitude toward adopting IoT technology in academia (beta=0.420***, *t*-value=4.605, *p*-value=0.000), so hypothesis 5 was supported. This means that perceived ease of use is the ultimate solution to adopting an IoT attitude. Attitude towards adopting technology did not significantly influence behavioral intention to use IoT (beta=$0.156^{n.s}$, *t*-value=1.790, *p*-value=0.073), so hypothesis 6 was not supported. Perceived usefulness significantly and positively influenced behavioral intention to use IoT (beta=0.423***, *t*-value=5.965, *p*-value=0.000), so hypothesis 7 was supported. Additionally, perceived ease of use significantly and positively influenced behavioral intention to use IoT (beta=0.283**, *t*-value=2.895, *p*-value=0.004), so hypothesis 8 was supported. The study further concluded that perceived usefulness has a higher effect on behavioral intention to use IoT than perceived ease of use, as shown in Table 7.

Table 7.
Path Coefficient

	Beta values	t-values	p-values
H6. **Attitude -> Behavioral Intention to use IoT**	0.156	1.790	0.073
H1. **Faculty Members' Self-efficacy -> Perceived Usefulness**	0.537	7.504	0.000
H2. **Faculty Members' Self-efficacy -> Perceived ease of use**	0.401	5.201	0.000
H4. **Perceived Usefulness -> Attitude**	0.190	1.664	0.096
H7. **Perceived Usefulness -> Behavioral Intention to**	0.423	5.965	0.000

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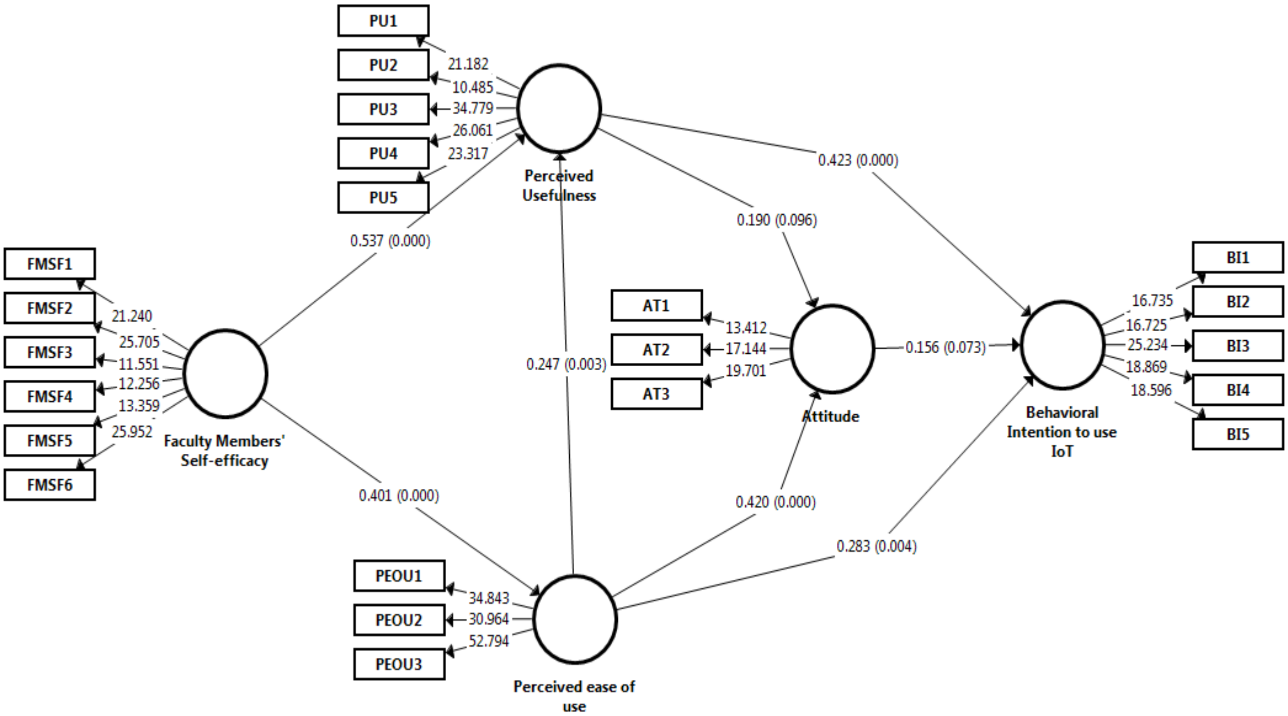
ISSN: 2386-4303 DOI https://doi.org/10.46661/ijeri.7461

use IoT			
H5. **Perceived ease of use -> Attitude**	0.420	4.605	0.000
H8. **Perceived ease of use -> Behavioral Intention to use IoT**	0.283	2.895	0.004
H3. **Perceived ease of use -> Perceived Usefulness**	0.247	2.984	0.003

Figure 2.
Structural equation modeling (SEM)



Model fitness (R^2 and Q^2).

The model's accuracy and sufficiency are evaluated using a battery of statistics known as R^2 and Q2 (Hair et al., 2021; Wang et al., 2021). Q^2 is a measure of model suitability and accuracy, while R^2 is a measure of variance (Mashal & Shuhaiber, 2018). The literature scholars suggested the threshold values for R^2 (i.e., ≥0.25 is a weak effect, ≥0.50 is a moderate effect, and ≥0.75 is a strong effect) and Q^2 (Hair et al., 2021; Mashal & Shuhaiber, 2018). The Q2 values for all predicted variables should be higher than zero (Hair et al., 2021). Finally, the study reported that faculty member self-efficacy explained 45.5% of the total variance in perceived usefulness and only 16% of the total variance in perceived ease of use. This means that faculty perception of IoT technology can improve performance more easily. Meanwhile, perceived usefulness and perceived ease of use explained 28.6% of the total variance in attitude toward adopting IoT technology. Perceived usefulness, perceived ease of use, and attitude in adopting IoT technology explained 49% of the variance in behavioral intention to use IoT technology.

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5. Discussion.

The study researches the adoption of IoT technology in higher academic institutions in Saudi Arabia. The study employed the technology acceptance model (TAM) to test the faculty members' behavioral intention to adopt IoT technology in higher academic institutions (HEIs). The study used a quantitative research design to test the proposed research hypotheses by using Smart PLS 3.3.3. The study targeted the faculty members of 8 universities in Saudi Arabia. The results reported that faculty member self-efficacy has a more significant and positive effect on perceived usefulness in adopting IoT technology than perceived ease of use. The results of both significant relationships are aligned with the literature studies (Abdullah, Ward & Ahmed, 2016; Fathema, Shannon & Ross, 2015; Holden & Rada, 2011; Jaafreh, 2018). The primary purpose of this research was to analyze how faculty members' self-efficacy affected their impressions of the internet's usability and utility. The goals were met by putting the two hypotheses, H1 and H2, under scrutiny. Consistent with previous studies, this one found that faculty members' self-efficacy significantly influenced how simple and useful faculty members found the internet (Fathema, Shannon & Ross, 2015). It showed that the more comfortable workers were in using the internet for web browsing, online searches, and communicating via electronic mail, the more intuitive, adaptable, and speedy the internet became for getting work done. According to the results, faculty members who have more confidence in their abilities are more likely to view IoT technology as beneficial and user-friendly than those who have less. In other words, faculty members who are comfortable with IoT usage (i.e., using fundamental features) are more likely to view it as a helpful technology and report lower complexity when employing it (Al-Abdullatif, Al-Dokhny & Drwish, 2022). Therefore, conscientious faculty members are more likely to use the IoT technology than those who are not.

Additionally, perceived ease of use significantly influenced perceived usefulness in adopting IoT technology. H3 was accepted and the result is aligned with the study of Joo, Park & Lim (2018). In the same way that faculty members can perceive the utility of technology when it is easy to use, they can also sense the usefulness of technology when it is useful. Faculty members need to be provided with sufficient time and opportunity to practice with emerging technologies until they reach a level of comfort that enables them to use the technology effectively and recognize that it contributes to effective instruction. Meanwhile, perceived usefulness failed to affect attitude toward adopting IoT technology, but perceived ease of use significantly and positively influenced attitude. H4 was rejected and H5 was supported, and the results are aligned with the studies of Fathema, Shannon & Ross (2015) and Abdullah, Ward & Ahmed (2016). Davis' (1989) arguments can be reformulated in the context of IoT adoption as follows: first, faculty members assess how simple or difficult it is to work with the IoT technology and then assess its value for them. They will develop a favorable attitude toward the technology if they find that it is "simple to use" and "helpful" for them (Jaafreh, 2018). They create a favorable intention to utilize it as a result of their good sentiments toward it. The final point is that their constructive goal affects how they use IoT technology. As a result, each original TAM component significantly predicted the respondent's desire to adopt IoT technology. The validity of the proposed expansion of the original TAM as a means of describing the attitude of faculty members toward IoT technology is supported by these findings.

Attitude toward adopting IoT technology does not significantly influence behavioral intention to adopt IoT technology. H6 was rejected and the result was opposed to the findings of Fathema, Shannon & Ross (2015), but consistent with the findings of Abdullah, Ward & Ahmed (2016). The findings demonstrated that the faculty members' perception of the Internet of Things' utility was the most important factor, followed by their perception of the IoT's simplicity of use, in determining whether or not faculty members intended to employ it in their future classrooms (Shannon & Ross, 2015). The results of this research imply that there is a need for more integration of IoT technologies in the design of instructional content and syllabi, and more training related to the inclusion of IoT technology as a useful approach to teaching and learning must be supplied to faculty members. Additionally, perceived usefulness and ease of use significantly and positively influenced behavioral intention to adopt IoT technology, and the hypotheses were accepted. However, the perceived usefulness was proved to be more significant for enhancing IoT technology. The result is consistent with the findings of Abdullah, Ward & Ahmed (2016).

6. Conclusion.

The findings highlight critical questions that need to be asked and answered before the adoption of IoT technology by faculty members in higher education institutions. According to the study's findings, perceived use and usefulness are significant aspects that play a role in the IoT technology usage of faculty members. As a result, those responsible for the design and formulation of university policy ought to place greater emphasis on enhancing the IoT quality to render it more readily usable by the teaching staff. Important aspects to concentrate on are the product's friendliness toward users, ease of access, and dependability. It is important that the IoT user interface, features, functionalities, contents, navigational speed, and interaction capabilities, among other aspects, be regularly monitored and developed based on the requirements of the teaching staff. It is recommended that a process for improving quality be carried out to maintain a higher quality level. This process will solicit feedback from IoT users regarding quality issues, problems, and recommendations for improvement, and it will guide IoT technology improvement actions following this feedback. Universities must regularly solicit feedback from users of learning management systems regarding their experiences with learning management systems, their challenges, and their suggestions for enhancing IoT technology. Based on the information gathered, institutions ought to work toward enhancing and modernizing IoT technology to provide better support for users. According to the research findings, a user's perception of their level of competence is a significant component in determining whether or not they will embrace IoT technology. Therefore, once a new IoT technology is implemented, it is essential to educate the faculty members about its characteristics, usefulness, and technical problems. This will allow the faculty members to acquire in-depth knowledge of the capabilities of the IoT and build confidence in using it. According to research conducted by Fathema and Sutton (2013), faculty members have expressed a desire for universities to provide comprehensive training, workshops, and awareness programs on IoT features, usage, and benefits to encourage increased faculty adoption of IoT technology.

In the same survey, instructors were asked if they would be more driven to learn and use IoT technology if they were aware that there was clear proof of the good influence that such technology can have on students' learning. Consequently, universities must offer regular training programs and prolonged expert support for the use of IoT technology to boost faculty members' self-efficacy and guarantee that more faculty members will utilize IoT technology. According to the findings of the study, the conducive conditions had a minimal but noticeable impact on the faculty members' attitudes toward IoT technology. As a result, educational institutions should pay careful attention to ensuring the availability of dependable network connectivity and technological assistance to guarantee IoT technology's efficient operation. Also, universities should give substantial assistance and advice to faculty members, both online and in-person, to ensure that faculty members have positive attitudes toward adopting IoT, which will, in turn, ensure that faculty members use Learning Management System (LMS) for a longer period (Hustad & Arntzen, 2013).

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This study proposed an understanding of the factors affecting educational institutions intention and behavior in using IoT. The results provided a prediction of the adopting IoT as a new technology in education. Using TAM gave answers and information for the concern of implementing IoT in education. This study examined the effects of TAM model variables in the context of IoT for future use in Saudi universities**.** Therefore**,** the model analysis gave a chance for more investigation in IoT implications. It can be used as a grounding model to examine the intention of adopting IoT as well as examining different variable that can contribute in the intention of using a new technology.

Limitations and future directions.

The study does have certain limitations. The research was conducted using only one IoT technology as a case study. Since data were only obtained from eight universities in Saudi Arabia using a method known as purposive sampling, the findings of the study may be only applicable to specific environments. It would be helpful to grasp the significance of this extended TAM if this study could be replicated in various environments and with different sample groups. It is highly recommended that researchers in the future give serious thought to evaluating the impact of three significant exogenous factors (i.e., system quality, facilitating conditions, and perceived self-efficacy) on the behavioral intention of adopting IoT technology in higher education institutions. Other variables such as social norms and anxiety are recommended to be examined for the intention of using IoT in Saudi universities. It is also important to examine the correlation between the students' performance and core variables of TAM. An important step in the right direction for future study would be to conduct follow-up qualitative research to learn more about faculty members' viewpoints regarding the adoption of IoT technology in universities. Future research is needed in exploring the intention of the use of IoT from universities students' views. More research also should be conducted in the opportunities and challenges that might face the adoption of IoT in universities system. Finally, the capablility of TAM in explaining variances in technology adoption, future studies can be applied to examine the implication of other technologies in universities, such as artificial intelligence (AI) and virtual reality (VR).

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